METRIC

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30 November 1977
(See 6.4)

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

FIBER OPTIC CABLING SYSTEMS REQUIREMENTS AND MEASUREMENTS

PHYSICAL, MECHANICAL, ENVIRONMENTAL AND MATERIAL MEASUREMENTS

(PART 3 OF 5 PARTS)

AMSC N/A

FSC 60GP

FOREWORD

1. This Department of Defense Standard Practice is approved for use by the Defense Supply Center Columbus, Defense Logistics Agency, and is available for use by all Departments and Agencies of the Department of Defense.

2. Comments, suggestions or questions on this document should be addressed to Defense Supply Center Columbus, ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990, or emailed to FiberOpticGroup@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.daps.dla.mil.

3. This standard practice provides detailed information and guidance to personnel concerned with ensuring standardization of fiber optic cable topologies (optical fiber cabling and associated components) on military mobile vehicles used in air, land and sea applications. In general, the requirements and methods specified herein are not identifiable to any specific mobile vehicle class or type, but are intended to standardize and minimize variations in requirements, test setups, test measurement procedures, test sample fabrication configurations and other aspects that must be addressed for completeness. Where specified, constrains for usage or platform types will be listed. The term “platform” will be used to refer to the military mobile vehicles in general or, where designated, one particular class (such as “aircraft platform”) or one particular type within that class (such as “F-35”).

4. In order to provide flexibility in the use and update of the different aspects for requirements and methods, this standard practice is issued in five parts; as follows:

   Part 1: Design, maintenance and installation requirements. This part addresses design requirements for platforms that use cable harnesses as the means to transport data through optical fiber among communication network and end user equipment. Larger platforms that route trunk cables through cableways and drop cables to the end user (application equipment), can cite applicable requirements in Part 1 of the Standard Practice and augment them with use of MIL-HDBK-2051 and MIL-STD-2042 as appropriate. Surface ships and submarines, are to use MIL-HDBK-2051 and MIL-STD-2042 in lieu of Part 1 of this Standard Practice.

   Part 2 Optical measurements. Part 2 of this standard addresses further details to refine or bound (constrain) the performance of each optical test measurement addressed. The test methods, such as those in a EIA/TIA-455 series standard or military standard/specification, are cited herein. This part of the standard practice augments the test method in the standard or specification to ensure consistency with setup and measurement procedure. This consistency minimizes variations when comparing data obtained from different test laboratories (including commercial, vendor, Government, and Government contractor).

   Part 3 Physical, mechanical environmental, and material measurements. Part 3 of this standard addresses further details to refine or bound (constrain) the performance of each physical, mechanical, environmental and material test measurement or inspection addressed. The test methods, such as those in a TIA-455 series standard or military standard/specification, are cited herein. This part of the standard practice augments the test method to ensure consistency with setup, measurement procedure, data recording/analysis and other factors critical to conducting or evaluating test performance. This consistency minimizes variations when comparing data obtained from different test laboratories (including commercial, vendor, Government, and Government contractor).

   Part 4 Test sample configuration and fabrication requirements. Part 4 of this standard addresses further details to refine or bound (constrain) the configuration and fabrication of test samples for the fiber optic components addressed. Fabrication methods, such as those in the Shipboard installation standard, MIL-STD-2042, or in the general series aircraft maintenance manual, NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4, are cited herein. This part of the standard practice augments the fabrication method to ensure consistency with use of the same components (such as cable types) and processes and augments the component specification to ensure consistency of the test sample configuration.

Part 5 Design phase and legacy measurements. Tests that are more unique to the design phase are addressed in Part 5 of this standard practice. Prequels for Part 2 of this standard practice contained other variants that are now excluded. These variants are now retained for informational purposes in Part 5. Also, Part 5 addresses some test methods cited in former DOD-STD-1678. The test methods cited in DOD-STD-1678 are considered obsolete; however, a few military specifications and commercial standards still refer to some of the test methods. These test methods are provided in this part of the standard with the recommended replacement method. These latter test methods are listed under the constraint that they be used only with the specific military specifications or commercial standards in which they are cited. The intent is to delete each DOD-STD-1678 test method from that standard practice in Part 5 once its reference from military specification or commercial standard is deleted.

CONTENTS

1. SCOPE

1.1 Scope. Part 3 of this standard practice provides further details to refine or bound (constrict) the performance of each physical, mechanical, environmental, and material test measurement addressed.

1.1.1 Applicability. The test methods, such as those in the TIA/EIA-455 series standard or military standard/specification, are cited already. This part of the standard practice augments the test methods in the TIA/EIA-455 series standard or military standard/specification to ensure consistency with setup and measurement procedure. This consistency minimizes variations when comparing data obtained from different test laboratories (including commercial, vendor, Government, and Government contractor). The rapidly changing state of the art in fiber optic technology makes it essential that some degree of flexibility be exercised in enforcing this document. When there is a conflict between this document and the platform specification or contract, the platform specification or contract shall take precedence. Where obsolescence or other issues are such that the measurement requirements specified for the refinement or bound (constraint) herein cannot be implemented, users shall submit a description of the issue along with a request for clarification or with proposal for redefining the requirement to consider for incorporation into this standard practice to: Defense Supply Center Columbus, ATTN: VAT, Post Office Box 3990, Columbus, OH 43218-3990, or emailed to FiberOpticGroup@dla.mil.

1.2 Intended uses for Part 3.

1.2.1 Primary uses of Part 3. Part 3 of this standard practice was prepared primarily for qualification functions performed by Government Personnel (including Government contractors acting on behalf of the Government) as specified in 1.2.1.1 through 1.2.1.3

1.2.1.1 Auditing. Use for performing audits of test laboratories doing testing for fiber optic cable topology (FOCT) components.

1.2.1.2 Test procedure review. Use to review physical, mechanical, environmental, and material test procedures for a FOCT component.

1.2.1.3 Test report review. Use to review the physical, mechanical, environmental, and material testing performance as part of a test report for a FOCT component.

1.2.2 Supplemental use. Part 3 of this standard practice is intended to identify to vendors and test laboratories the areas of emphasis for Government review for physical, mechanical, environmental, and material test measurements performed as part of a FOCT component qualification process.

1.2.3 Use for content. Each physical, mechanical, environmental, and material measurement augments the test methodology and performance requirements in a narrative format to the extent deemed necessary for that measurement. Checklists may be included that contain primary requirements in a table format. When a checklist is included, further clarification of the items in the table can be found in applicable physical, mechanical, environmental, or material measurement.

1.2.4 Constraints on use.

a. Commercial entities are expected to be familiar with the test standards cited by the Government for use. Part 3 of this standard practice does provide some guidance and clarifications for successful implementation within the test standards cited.

b. Part 3 of this standard practice is not intended to be used in lieu of a test laboratory developing physical, mechanical, environmental, and material test procedures specific to the fiber optic component military specification.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE DRAWINGS

NAVAIR 01-1A-505-4/ T.O. 1-1A-14-4/ TM 1-1500-323-24-4	-	Aircraft Fiber Optic Cabling, Technical Manual, Installation and Testing Practices.

(Copies of this document can be obtained at web site: https://jswag.navair.navy.mil. At the home page select "Document Library" (on left side), select "Committee" then select "JFOWG" folder followed by the "Maintenance Documents" folder.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA-440	-	Fiber Optic Terminology.
TIA/EIA-455	-	Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS.

3.1 General fiber optics terms. Definitions for general fiber optics terms used in this standard practice are in accordance with TIA-440. Definitions for other terms as they are used in this standard practice are given in the following paragraphs.

3.2 Acronyms. The following acronyms are used in this standard practice:

DUT	Device under test
FOCT	Fiber optic cable topology
QPL	Qualified Products List

3.3 Qualification testing, general. Formal testing designed to demonstrate that the software and hardware of a system meet specified requirements. Qualification testing may be accomplished at any time during the life of a system, such as during prototype development, manufacturing, shipment, storage, installation, and operation. Most often the qualification testing is conducted to determine the extent to which a system passes a specified set of performance criteria.

3.4 Qualification testing, QPL process. For purposes of this Standard Practice, qualification testing is refined and bounded to the term as used for Government Qualified Products List (QPL) testing or inspection. This testing is performed to determine if the FOCT (fiber optic cable topology) component or DUT (device under test) meets the requirements specified in the fiber optic component applicable military specification. Physical, optical, mechanical, environmental, and material testing is performed in specified test sequences. One parameter is tested at a time. Successful completion places the DUT onto the QPL for that FOCT component military specification. Other terminology is to be used in lieu of qualification for any prototype development, manufacturing, shipment, storage, installation, and operational testing.

4. GENERAL REQUIREMENTS

4.1 Environmental conditions. Test equipment to perform and instrumentation to measure the specified parameters for each physical, mechanical, environmental and material test must be placed in an area in which specified ambient temperature and humidity conditions are maintained. "Standard Ambient" conditions (23°C ±5°C/73°F ±9°F and 20 percent RH to 70 percent RH), in accordance with TIA/EIA-455, is acceptable if the test equipment is built to operate throughout that ambient temperature and humidity range and is within the specified accuracy. If not, then the "Controlled Ambient" conditions (23°C ±2°C/73°F ±4°F and 45 percent RH to 55 percent RH) are to be followed. For uncontrolled spaces where local weather is normally within the "Standard Ambient" range (or the specified test equipment operating ambient conditions, whichever is more conservative), testing shall be performed only when the acceptable conditions exist.

4.2 Vendor minimum inspection responsibilities. When the vendor has in house capabilities to perform group A inspections, the vendor is encouraged to do the initial qualification inspections that are also listed under group A inspections. When the initial qualification is done inside the vendor's facility, the vendor should submit the results of the qualification inspections equivalent to group A inspections to the outside test laboratory for inclusion as part of the initial qualification report.

4.3 Test conditions.

4.3.1 Test interruption.

4.3.1.1 Occurrence. Test interruption is considered to occur any time the test parameters fall outside of the ones specified. An example would be a temperature deviation exceeding ±2°C.

4.3.1.2 Corrective action. Once a test interruption occurs, the test sample shall be brought back to the unstressed condition at a controlled rate. The test shall then be continued from the point of repeating the last cycle prior to the interruption. For tests in which cycling is not performed, the test shall then be continued from the point of repeating the last action (as with the case of a mechanical test) or be continued from the point of repeating the last 12 hours (as with the case of an environmental soak type test). If collecting data during the test, start re-collecting data after repeating the last action or repeating the last 12 hours, as applicable.

4.3.2 Environmental chamber test charts.

4.3.2.1 Requirement. Defense Supply Center Columbus (DSCC) specifies detailed data requirements for some test methods. Test charts are required for tests performed in environmental chambers and contain recordings of the environmental conditions (such as temperature and humidity) inside the chamber. The test chart is to include the environmental chamber manufacturer, model, and serial number with the date of the recording.

4.3.2.2 Implementation. Objective evidence that test requirements were achieved whether it be circular chart, stored data on disk or by other means approved by the qualification activity. Any stored data must be retained and made available to the Government upon request.

4.3.3 Recording and verifying pass/fail criteria.

4.3.3.1 Proper test criteria must be specified. Pass/fail criteria must be stated in the test procedure and available to the operating personnel performing the test.

4.3.3.2 Proper test fail criteria must be implemented. Operating personnel performing the test are to be knowledgeable in what constitutes a failure. The test laboratory shall determine if the result of each performance requirement for a test is a pass or fail and record that determination on the data sheet. A description of any failure is to be noted on the data sheet or supplemental documentation. Corrective measures, within the scope of the test setup (such as cleaning and reseating), are to be taken to resolve a failure. The corrective measures taken in trying to resolve a failure shall be recorded. If subsequent measurements obtained remain outside of the performance requirements, it is designated a failure. Alternative terminology (such as discrepancy or deviation) is not to be used.

4.3.3.3 Government determination of marginal performance. Government personnel, upon review of test documentation and instrumentation specifications, may determine that data just outside of the performance requirement is marginal. Allowance for this determination is made when using specialized test equipment for a more unique measurement. This allowance is not applicable for test equipment used in most of the optical tests conducted.

4.4 Safety compliance while performing testing.

4.4.1 Fiber optic safety precautions. The fiber optic safety precautions listed in subordinate Work Package 004 01 of NAVAIR 01-1A-505-4/T.O. 1-1A-14-4/TM 1-1500-323-24-4 shall apply. Verify, at a minimum, that operating/test personnel are aware of 4.4.1a through 4.4.1m.

a. Keep all food and beverages out of the work area. If fiber particles are ingested they can cause internal injury.

b. Do not smoke while working with fiber optic systems.

c. Always wear safety glasses with side shields. Treat fiber optic splinters the same as glass splinters.

d. Never look directly into the end of fiber cables until you are positive that there is no light source at the other end. Use a fiber optic power meter to make certain the fiber is dark.

e. Do not touch the ends of the fiber, as they may be razor sharp. Rinse hands thoroughly under running water to rinse away any glass shards.

f. Contact wearers must not handle their lenses until they have thoroughly rinsed and then washed their hands.

g. In the event glass shards enter the eye or penetrate the skin seek medical attention immediately.

CAUTION: Do not rub your eye. Only authorized medical personnel should attempt removal of glass shards from the eye. Do not attempt removal of glass from the eye yourself!

h. Do not touch your eyes while working with fiber optic systems until your hands have been thoroughly cleaned.

i. Clean hands thoroughly first by rinsing hands under running water to rinse away any glass shards after handling and repairing fiber. Then wash normally. Wear protective gloves if at all possible.

j. Keep all combustible materials safely away from heat sources.

k. Ultraviolet (UV) safety glasses shall be worn when using the UV curing lamp.

l. Only work in well-ventilated areas.

m. Avoid skin contact with epoxies.

4.5 Consensus for physical, mechanical, environmental, and material measurements. Part 3 of this Standard Practice is a compilation of existing requirements previously released in the form of other documents. Consensus was obtained among various Government activities, responsible for specifying the performance of fiber optic cabling components and systems/networks, on the requirements documented herein. These same Government activities shall be the means to reach consensus on standardization of new/revised requirements, identify new requirements and new technologies that permit its rapid introduction, and provide those requirements to update Part 3 of this Standard Practice.

4.6 Groupings of tests. Measurements in Part 3 of this Standard Practice are placed into four groups (of “physical”, ”mechanical”, “environmental”, and “material”). Some measurements can be placed into more than one group or considered more appropriately apart of a different group not listed. For instance, vibration may be considered either environmentally induced or resulting from mechanical stress. With some liberties, the four groups are taken from the qualification inspection tables for fiber optic components. These groups are taken from the sequence of tests performed in each group for the majority of the fiber optic component military specifications. There are variations within each military specification.

4.6.1 Physical group. The physical group includes those visual, dimensional, and other inspections that can be done on piece parts (components) prior to test sample fabrication or assembly. The physical group measurements are found mainly in 3101, 3102, 3103, 3104 and 3105 inspections.

4.6.2 Mechanical group. The mechanical group includes measurements in which an external stress is induced using a test fixture. The mechanical group measurements are mainly found in 3201, 3202 and 3203 inspections.

4.6.3 Environmental group. The environmental group includes measurements in which temperature, humidity or both temperature and humidity induced stresses are applied within a cabinet or chamber (referred to herein as climatic type environmental measurements). The environmental group measurements are mainly found in 3301, 3302, 3303, 3304, 3305, 3306, 3307 and 3308 inspections.

4.6.4 Material group. The material includes measurements in which primarily the degree that a material property can withstand an environment or stress is usually applied within a vessel or chamber (also referred to as material assessment type environmental conditions). These material type measurements are mainly found in 3401, 3402, 3403, 3304, 3405, 3406, 3407, 3408 and 3409 inspections. Due to measuring the ability to withstand a specific environment, the majority of these type measurements could be grouped under environmental rather than a separate material group.

4.7 Inspection by attributes. The random sampling alternative and inspection by attributes are applicable for the specified conformance inspections only. For qualification and for initial validation of the process, inspection shall be performed on 100 percent of samples with data supplied. Data includes a value and unit of measure for each measurement required on each sample. Inspection by attributes is an assessment in which each sample is measured then rated as conforming or nonconforming with respect to a given specification requirement or set of requirements (no measurement data provided).

4.8 Data sheets. Measurement data shall be provided in the form on data sheets. Data sheets shall conform to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201. In addition, the data sheet shall list the items specified for each measurement. Sample data sheets are illustrated for some measurements in Part 3 of this Standard Practice. The illustrations do not include the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201. The items on the standard data sheet may be listed on each data sheet prepared, or as an alternative, may be listed on a separate data cover sheet.

5. DETAILED REQUIREMENTS

5.1 Physical measurements. Measurements shall be implemented as specified in 5.1.1 through 5.1.5.

5.1.1 Size. Measurements shall be performed to measurement 3101.

5.1.2 Weight. Measurements shall be performed to measurement 3102.

5.1.3 Workmanship. Measurements shall be performed to measurement 3103.

5.1.4 Markings. Measurements shall be performed to measurement 3104.

5.1.5 Visual and mechanical. Measurements shall be performed to measurement 3105.

5.2 Mechanical measurements. Support processes for measurements shall be implemented as specified in 5.2.1 through 5.2.3.

5.2.1 Vibration. Measurements shall be performed to measurement 3201.

5.2.2 Shock (mechanical). Measurements shall be performed to measurement 3202.

5.2.3 Cable scraping resistance. Measurements shall be performed to measurement 3203.

5.3 Environmental measurements. Environmental measurements that include those that apply stress types such as temperature, humidity, or both temperature and humidity inside a cabinet or chamber (grouped as climatic and similar type measurements) shall be implemented as specified in 5.3.1 through 5.3.8.

5.3.1 Temperature cycling. Measurements shall be performed to measurement 3301.

5.3.2 Temperature-humidity cycling. Measurements shall be performed to measurement 3302.

5.3.3 Temperature life. Measurements shall be performed to measurement 3303.

5.3.4 Thermal shock. Measurements shall be performed to measurement 3304.

5.3.5 Altitude immersion. Measurements shall be performed to measurement 3305.

5.3.6 Weathering. Measurements shall be performed to measurement 3306.

5.3.7 Freezing water immersion. Measurements shall be performed to measurement 3307.

5.3.8 Electromagnetic effects. Measurements shall be performed to measurement 3308.

5.4 Material measurements. Material measurements that include those in which a material property can withstand a specified degree of environment or stress usually applied within a vessel or chamber shall be implemented as specified in 5.4.1 through 5.4.9.

5.4.1 Fungus resistance. Measurements shall be performed to measurement 3401.

5.4.2 Salt spray. Measurements shall be performed to measurement 3402.

5.4.3 Modified SO_2/salt spray. Measurements shall be performed to measurement 3403.

5.4.4 Ozone exposure. Measurements shall be performed to measurement 3404.

5.4.5 Smoke generation and flame propagation. Measurements shall be performed to measurement 3405.

5.4.6 Flame extinguishing. Measurements shall be performed to measurement 3406.

5.4.7 Toxicity index. Measurements shall be performed to measurement 3407.

5.4.8 Shell-to-shell conductivity. Measurements shall be performed to measurement 3408.

5.4.9 Fluid immersion. Measurements shall be performed to measurement 3409.

6. NOTES.

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The measurements depicted in this standard practice are intended for qualification testing; however, they are applicable for other types of test or evaluation programs that require these specific measurements for fiber optic cabling components used on military mobile vehicles (such as platforms).

6.2 Subject term (key word) listing.

Test sample configuration
Physical, mechanical, environmental and material measurements
Fiber optic cabling

6.3 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue, due to the extent of the changes.

6.4 Supersession data. The five parts of MIL-STD-1678 replace superseded DOD-STD-1678 with completely new fiber optic requirements and measurements. With the exception of some legacy material in MIL-STD-1678-5, none of the fiber optic test and measurement material comprising superseded DOD-STD-1678 has been included. With the exceptions noted in Part 5 of this standard practice, this standard practice should be applied in lieu of the legacy methods in superseded DOD-STD-1678.

PHYSICAL MEASUREMENTS

3101 - 3105

MEASUREMENT 3101

SIZE

1. Purpose. This measurement is intended to provide further direction for equipment, setup, processes, and evaluation criteria for ensuring that the mechanical inspection for size is done in a consistent manner. This mechanical inspection is for "fit" only, as specified in TIA-455-13. No mechanical examination is performed for function, such as verifying interoperability, interface with mating components or (mechanical and optical) operation. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations, and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA-455-13 - Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Size. The mechanical inspection for "fit" that consists of measuring the dimensions of the DUT specified in the component military specification or at a minimum, the dimensions for interoperability and compliance within a specified footprint (envelop dimensions).

4. Setup. Measurement 3101 shall be conducted in accordance with the setup specified TIA-455-13 with the restrictions specified in 4.1 through 4.4.

4.1 Placement in test order. Size inspection shall occur prior to any fabrication of a DUT assembly (assembling the DUT with other fiber optic components to make the test samples).

4.2 DUT disassembly. DUT may be disassembled to the subcomponent level to obtain the required dimensional measurements. Unless otherwise specified, no disassembly shall be performed at the subcomponent level. No disassembly shall be performed that involves welded, riveted, bonded, or otherwise mechanically or chemically affixed parts.

4.3 Special measurement equipment or devices. No special measurement tool that makes a quantitative measurement is exempt from calibration. A special measurement device that is used to make the measurement shall be referred to as a special measurement tool versus fixture.

4.4 Measurement equipment. Unless otherwise specified, measurement equipment (instrument or tool) accuracy shall be ±0.02 mm (±.001 inch).

5. Test procedure. Measurement 3101 shall be conducted in accordance with the methodology specified TIA-455-13 with the restrictions for processes and evaluation criteria specified. Measurement processes shall include those summarized in 5.1 through 5.4.

5.1 Dimensional measurements. Dimensions on the DUT obtained as part of qualification shall include those listed in 5.1a through 5.1c.

a, Dimensions required for interoperability.

b. Maximum dimensions specified as the footprint or envelop.

c. Dimensions specified as part of the fiber optic component military specification.

5.2 Special processes. Test procedure for dimensional measurements shall contain the steps or processes for obtaining measurements that require special techniques or tools. Special processes are those in which measurement equipment is not used directly and the measurement is not straight forward.

5.3 Pass/fail criteria. Test equipment used shall be capable of measurement to the accuracy specified by the pass/fail criteria.

5.4 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet shall include the contents illustrated in method 3101 appendix A.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3101

APPENDIX A

SIZE SAMPLE DATA SHEET

Excerpts to illustrate features for a dimensional inspection sample data sheet

A1 Dimensional inspection samples.

a Excerpt from a data sheets to illustrate use of figures for indicating (1) points at which to take the measurement, (see figure 3101 A1), (2) view in which measurement can best be obtained, (see figure 3101 A2) and (3) supplemental views to best show points for particular measurements (see figure 3101 A3).

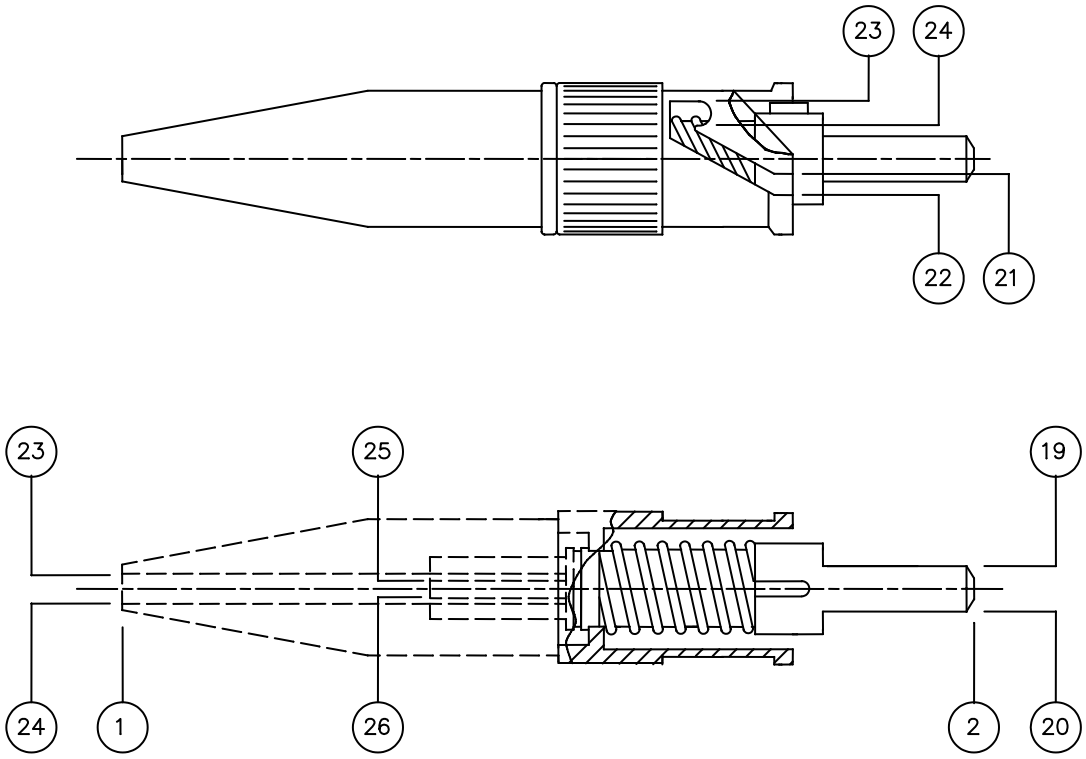
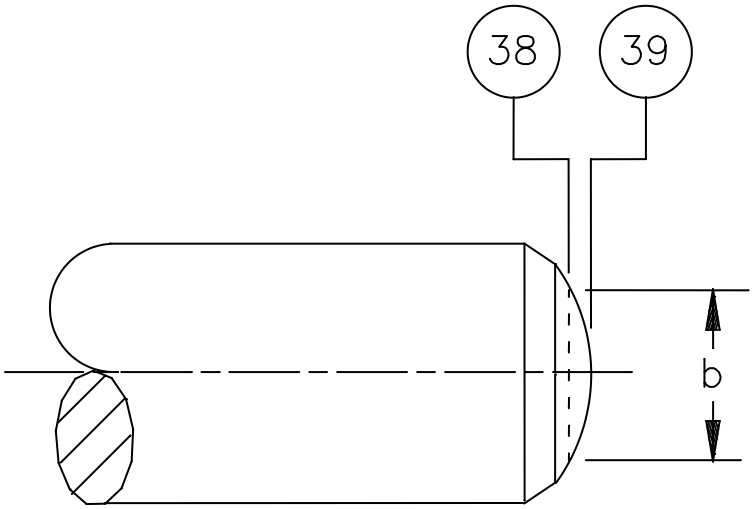


FIGURE 3101 A1. Figure showing points at which to take the measurement.



NOTE: "b" equals 2.00 mm (.079 inches) diameter is used to determine ferrule dome height (38) - (39)

FIGURE 3101-A2. Figure showing view in which parameter for determining where dimensions are taken.

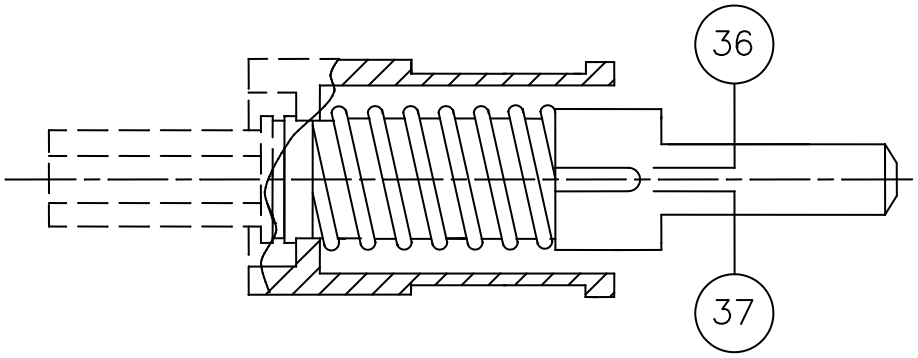


FIGURE 3101-A3. Figure showing points for particular measurements.

b. Excerpt from a data sheet to illustrate how the data sheet may be organized and optimized for the obtaining and recording proper measurements. For instance, the measurements may be arranged by different views (such as side, front profile), by measurements obtained with and without certain parts, and by which figure on the data sheet pertains to a specific measurement (when dimensional data sheet has multiple views and details). See table 3101-AI.

APPENDIX A

TABLE 3101-AI. Sample data sheet for figures 3101 A1 and 3101 A2.

Test #	Max	Min	Sample #	P/F	Sample #	P/F	Sample #	P/F	Sample #	P/F
Measurement made after realigning the connector to view the opposite end face as shown in figure 3101-A1										
Width of fiber without jacket: dist. 23-24	0.126	0.079								
Measurement made after replacing the strain relief boot and keeping the same alignment as shown in figure A1										
Width of fiber with buffer: dist. 25-26	0.063	0.041								
Measurements made when ferrule is oriented as shown in figure A2										
Ferrule (X) dome: dist. 38-39	0.0025 0.0025	0.0006 0.0000								

c Excerpt from a data sheet to illustrate use of a supplemental measurement device or tool for obtaining a measurement (such as a distance or linear measurement by using gauge pins - see last distance dimension in excerpt, see table 3101-AII).

TABLE 3101-AII. Sample data sheet for figure 3101 A1 and 3101 A3.

Test #	Max	Min	Sample #	P/F	Sample #	P/F	Sample #	P/F	Sample #	P/F
Overall length dist. 1-2	1.22 Ref	1.08 ref								
Ferrule diameter: dist. 19-20	0.635 Ref	0.538 1/								
Slot width 1: dist. 21-22	0.058	0.044								
Slot width 2: dist. 23-24	0.058	0.044								
Shoulder to shoulder dist. 25-26 2/:	0.600	0.560								
Tab width, Dist. 36-37	0.042	-0.036								

NOTES:
1. For optical comparator programming only.
2. Measure with pins inserted from both sides

MEASUREMENT 3102

WEIGHT

1. Purpose. This measurement is intended to provide further direction for equipment, setup, processes, and evaluation criteria for ensuring that the mechanical inspection for weight is done in a consistent manner. This mechanical inspection is for "fit" only, as specified in TIA-455-13. No mechanical examination is performed for function, such as verifying interoperability, interface with mating components, or (mechanical and optical) operation. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA-455-13 - Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Balance. A lever device or mechanism used to compare a known mass with an unknown mass. The balance will provide the same measurement anywhere on the earth (since any local effect on gravity acts equally on both the known and unknown masses).

3.2 Mass. The term used as a measure of resistance to change in motion of an item when a force is applied without the influence of gravity. When calculating the mass from a weight measurement using a scale, the nominal standard gravity of 9.80665 m/sec^2 (32.174 ft/sec^2) shall be used for qualification conversions.

3.3 Scale. A spring, hydraulic, or pneumatic device used to measure the local force of gravity on the item.

3.4 Standard weight. A term used to refer to a known mass that has been calibrated in units of mass.

3.5 Weight. The mechanical inspection for "fit" that consists of measuring the mass of the DUT relative to the force of gravity, as specified in the component military specification. Since the local force of gravity may vary up to 0.5 percent at different locations, scales measure different values of weight at different locations for the same item (or same mass).

4. Setup. Measurement 3102 shall be conducted in accordance with the setup specified TIA-455-13 with the restrictions specified in 4.1 through 4.3.

4.1 Placement in test order. Weight inspection shall occur prior to any fabrication of a DUT assembly (assembling the DUT with other fiber optic components to make the test samples).

4.2 DUT disassembly. No disassembly shall be performed at the component level.

4.3 Measurement equipment. Measurement equipment (scale or balance) accuracy shall be ±5 percent of span. Measurement equipment shall be within 10 to 90 percent of the range and have sufficient resolution to obtain measurement to within specified accuracy.

5. Test procedure. Measurement 3102 shall be conducted in accordance with the methodology specified TIA/EIA-455-13 with the restrictions for processes and evaluation criteria specified. Measurement processes shall include those summarized in 5.1 through 5.3.

5.1 Mass measurements. Measurement can be performed as specified in either 5.1.1 or 5.1.2.

5.1.1 Weight measurement. Weight of the DUT may be obtained using a scale. Mass shall then be calculated using the nominal standard gravity (see 3.2).

5.1.2 Mass measurement. Mass of the DUT may be obtained directly using a balance.

5.2 Pass/fail criteria. Test equipment used shall be capable of measurement to the accuracy specified by the pass/fail criteria.

5.3 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet shall include the items listed in 5.3a through 5.3d.

a. Type of measurement equipment (balance or scale).

b. Parameters if balance is used. Masses and accuracies of standards weights used, resolution of balance.

c. Parameters if scale is used. Range, resolution, and accuracy of scale used.

d. Table with each measurement obtained with units of measure.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3103

WORKMANSHIP

1. Purpose. This measurement is intended to provide further direction for equipment, setup, processes, and evaluation criteria for ensuring that the visual and mechanical examinations performed for the workmanship inspection are done in a consistent manner and as specified in TIA-455-13. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

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2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Workmanship. The visual and mechanical inspections performed to qualitatively assess the degree or level of quality for the fabrication of the DUT as a completed component.

4. Setup. Measurement 3103 shall be conducted in accordance with the setup specified in TIA-455-13 with the restrictions specified in 4.1 through 4.4.

4.1 Placement in test order. Workmanship inspection shall occur prior to any fabrication of a DUT assembly (assembling the DUT with other fiber optic components to make the test samples).

4.2 DUT disassembly. DUT may be disassembled to the subcomponent level to inspect for the parameters specified in 5.1. Unless otherwise specified, no disassembly shall be performed at the subcomponent level. No disassembly shall be performed that involves welded, riveted, bonded, or otherwise mechanically or chemically affixed parts.

4.3 Special measurement equipment or devices. No special tools shall be used as part of this inspection to assess functionality of the DUT.

4.4 Measurement equipment. Unless otherwise specified, this visual inspection shall be done without magnification. As required, an optical magnifier may be used. Optical magnification for this inspection shall be limited to 3X to 5X.

5. Test procedure**.** Measurement 3103 shall be conducted in accordance with the methodology specified in TIA-455-13 with the restrictions for processes and evaluation criteria specified. Measurement processes shall include those summarized in 5.1 and 5.2.

5.1 Inspections. Inspections performed on the DUT obtained as part of qualification shall include those listed in 5.1.1 through 5.1.8.

5.1.1 Loose parts. Parts which adversely affect the environmental sealing or permit cable sealing, do not prevent penetration or degrade optical contact alignment are not acceptable.

5.1.2 Surface finish imperfections. Peeling or chipping of plating or finish, galling of wear, nicks, burrs, or other surface finish substandard blemishes or imperfections are not acceptable.

5.1.3 Part imperfections. Product/parts are not dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces, inclusions, or other imperfections.

5.1.4 Inner part imperfections. Inner parts contain fractures, holes, discontinuities, bulges, thin spots or other imperfections.

5.1.5 Cabling imperfections. Cable parts, cable or strength members are not uniformly laid or have discontinuities. Fillers and water sealant are not uniformly distributed throughout the cable body.

5.1.6 Mateability. Verify the connectors, adapters, and other interconnecting devices (mateable items) mate and unmate easily and make proper connection.

5.1.7 Functionality. Verify all mechanical mechanisms function properly. Ensure spring and latch mechanisms do not interfere with other components (cable fit into connector). Ensure knobs, button, and threaded components operate properly.

5.1.8 Installation. Verify all parts are assembled and seated properly.

5.2 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet shall include the contents illustrated in appendix A.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3103

APPENDIX A

WORKMANSHIP INSPECTION SAMPLE DATA SHEET

A.1. Workmanship, visual.

a. Loose parts.

Criteria: No loose inserts or other parts which adversely effect environmental sealing, permit cable sealant penetration, or degrade optical contact alignment. Specify on data sheet.

Pass____ All parts included.

Fail____ Part(s) are missing. Specify on data sheet.

b. Finish Imperfections.

Criteria: No peeling or chipping of plating or finish, galling of wear, nicks, burrs, or other surface finish substandard blemishes or imperfections. Specify on data sheet.

Pass____ No finish imperfections observed that is detrimental to form, fit, or function or that could result in further protective coating or material degradation.

Fail____ Observed sufficient peeling or chipping of plating or finish, galling of wear, nicks, burrs, or other surface finish substandard blemishes or imperfections.

c. Surface Imperfections.

Criteria: No rust, burnt areas, abrasions, holes, rough-head areas, bulges, thin spots, or indentations.

Pass____ No surface imperfections observed that are detrimental to form, fit, or function or that could result in further protective coating or material degradation.

Fail____ Observed sufficient rust, burnt areas, abrasions, holes, rough-head areas, bulges, thin spots, or indentations. Specify on data sheet.

d. Part imperfections.

Criteria: Product/parts are dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces, inclusions or other imperfections.

Pass____ No part imperfections observed that are detrimental to form, fit, or function or that could result in further protective material or function degradation

Fail____ Observed product/parts are not dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces, inclusions, or other imperfections. Specify on data sheet.

e. Inner part imperfections.

Criteria: Inner parts contain no fractures, holes, discontinuities, bulges, thin spots, or other imperfections.

Pass____ No inner part imperfections observed that are detrimental to form, fit, or function or that could result in further material or function degradation

Fail____ Observed inner parts contain fractures, holes, discontinuities, bulges, thin spots, or other imperfections. Specify on data sheet.

f. Cabling imperfections.

Criteria: Cable parts, Cables or strength members are not uniformly laid or have discontinuities. Fillers and water sealant are not uniformly distributed throughout the cable body.

Pass____ No cabling imperfections observed that are detrimental to form, fit, or function or that could result in further material or function degradation.

Fail____ Observed, cable parts cables or strength members are not uniformly laid or have discontinuities. Specify on data sheet.

____ Observed fillers and water sealant are not uniformly distributed throughout the cable body. Specify on data sheet.

A.2. Workmanship, mechanical.

a. Mateability.

Criteria: Connectors, adapters, and other interconnecting devices (mateable items) mate and unmate easily and make proper connection.

Pass____ No mateability or other mechanical interconnects observed that are detrimental to form, fit, or function or that could result in preventing mating.

Fail____ Connectors, adapters, and other interconnecting devices (mateable items) do not mate and unmate easily or do not make the proper connection. Specify on data sheet.

____ Matable items will not mate. Specify on data sheet.

____ Mateable items were damaged during mating. Specify on data sheet.

____ Mateable items did not make proper connection. Specify on data sheet.

MEASUREMENT 3103

b. Functionality.

Criteria: Mechanical mechanisms function properly. Spring and latch mechanisms do not interfere with other components (cable fits into connector). Knobs, button, and threaded components operate properly.

Pass____ No mechanical mechanism malfunction observed that are detrimental to form, fit, or function or that could result in further material or function degradation.

Fail____ Spring and latch mechanisms will interfere with other components (cable fit into connector). Specify on data sheet.

____ Knobs, button, and threaded components do not operate properly. Specify on data sheet.

c. Installation.

Criteria: Parts are assembled and seated properly.

Pass____ No observed parts that are assembled or seated in a manner that are detrimental to form, fit, or function or that could result in further material or function degradation.

Fail____ Improperly seated or assembled parts. Specify on data sheet.

Details on failures recorded:

MEASUREMENT 3103

MEASUREMENT 3104

MARKING

1. Purpose. This measurement is intended to provide further direction for equipment, setup, processes, and evaluation criteria for ensuring that the visual inspection for markings is done in a consistent manner and as specified in TIA-455-13. No mechanical examination is performed for function, such as testing to verify durability or permanency. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations, and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-130	-	Identification Marking of U. S. Military Property.
MIL-STD-1285	-	Marking of Electrical and Electronic Parts.

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

EIA-359	-	Standard Colors for Color Identification and Coding.
TIA-455-13	-	Visual and Mechanical Inspection of Fiber Optic Components, Devices, and Assemblies.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Marking. The visual inspection that consists of assessing lines, lettering (such as text, serial numbers, and date codes), and patterns (such as a logo or symbol) added on the surface of the DUT as specified in the component military specification.

4. Setup. Measurement 3104 shall be conducted in accordance with the setup specified TIA-455-13 with the restrictions specified in 4.1 through 4.3.

4.1 Placement in test order. Marking inspection shall occur initially prior to any fabrication of a DUT assembly (assembling the DUT with other fiber optic components to make the test samples). Subsequent marking inspections may occur after performing a sequence of other tests.

4.2 DUT disassembly. Restrictions of DUT disassembly shall comply with 4.2.1 through 4.2.3.

4.2.1 External surface markings. No DUT disassembly shall be performed.

4.2.2 Interior surface markings. No DUT disassembly shall be performed other than to un-mate connections or remove covers/panels.

4.2.3 General. No disassembly shall be performed at the subcomponent level. No disassembly shall be performed that involves welded, riveted, bonded, or otherwise mechanically or chemically affixed parts.

4.3 Measurement equipment.

4.3.1 Dimensional measurements. Unless otherwise specified, measurement equipment (instrument or tool) accuracy shall be ±0.02 mm (±.001 inch).

4.3.2 Optical magnification. Unless otherwise specified, this visual inspection shall be done without magnification. As required, an optical magnifier may be used. Optical magnification for this inspection shall be limited to 3X to 5X.

5. Test procedure. Measurement 3104 shall be conducted in accordance with the methodology specified TIA-455-13 with the restrictions for processes and evaluation criteria specified. Visual inspection shall include those summarized in 5.1 through 5.4. Markings include the manufacturer's name, symbol, CAGE Code, logo or trademark, and PIN (Part Identification Number).

5.1 Easily identifiable. Visually inspect the DUT as part of this qualification to ensure that identification markings are identifiable as specified in 5.1.1 through 5.1.4.

5.1.1 Marking height on exterior body or shell. Marking characters shall be a minimum of 1.02 mm (.040 inch) in height.

5.1.2 Maximum number of characters on exterior body or shell. Maximum number of characters around diameters of cylindrical part or on flat surface shall be in accordance with 6.4.2 of MIL-STD-1285.

5.1.3 Location on exterior body with respect to installation. Marking location on shell shall be in a location to ensure readability when installed (in accordance with appendix G of MIL-STD-1285).

5.1.4 Location on connector inserts. Markings of terminus cavities shall be on front and rear of inserts (refer to fiber optic component military specifications for designations)

MEASUREMENT 3104

5.2 Legibility and permanency (in accordance with MIL-STD-130). Visually inspect the DUT as part of this qualification to ensure that identification markings are permanent and legible as specified in 5.2.1 through 5.2.3.

5.2.1 Legibility. Markings shall be readily readable. Color contrast between characters and surface shall be good. Markings shall be considered legible when each character can be easily identified, even if some of the print is faded or removed.

5.2.2 Permanency. Normal life expectancy of markings shall appear achievable. Markings shall be capable of withstanding the environmental tests and cleaning procedures. DUT shall be considered as permanently marked if markings remain legible after completion of qualification tests.

5.2.3 Restrictions on character height. Raised or depressed characters shall not be used on mating surfaces.

5.3 Color codes and bands. Visually inspect the DUT as part of this qualification to ensure that identification markings are properly color coded as specified in 5.3.1 through 5.3.3.

5.3.1 Conformance to color code. Color code shall conform to limits of centroid colors in accordance with EIA-359 (use Munsel color chart book by Gretag Macbeth). During testing, colors shall remain within specified Munsel color limits from the centriod colors.

5.3.2 Fiber optic identification band for connectors. Connector shall be marking with either a yellow band or the words “Fiber Optics”.

5.3.3 Terminus TICC bands. Terminus shall contain 4 color coded bands or equivalent numbers, as specified in the fiber optic component military specification. Bands shall be color coded for the particular maximum ferrule hole diameter and body type. Color coding used shall conform to the following numbering scheme for the four TICC bands: 0 = black, 1 = brown, 2 = red, 3 = orange, 4 = yellow, 5 = green, 6 = blue, 7 = violet, 8 = gray, 9 = white.

5.4 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet shall include the contents illustrated in appendix A.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3104

APPENDIX A

MARKING INSPECTION SAMPLE DATA SHEET

If a failure is recorded, provide details on the extent of the failure observed (on bottom on data sheet).

Easily identifiable.

Character height on exterior body or shell.

Criteria: Marking characters shall be a minimum of .040 inch (1.02 mm) in height. Raised or depressed characters shall not be used on mating surfaces.

Pass____ Fail____

Maximum number of characters on exterior body or shell.

Criteria: Maximum number of characters around diameters of cylindrical part or on flat surface shall be in accordance with 6.4.2 of MIL-STD-1285.

Pass____ Fail____

Location on exterior body with respect to installation.

Criteria: Marking location on shell shall be in a location to ensure readability when installed (in accordance with appendix G, MIL-STD-1285).

Pass____ Fail____

Location on connector inserts.

Criteria: Markings of terminus cavities shall be on front and rear of inserts (refer to fiber optic component military specifications for designations).

Pass____ Fail____

Legibility and permanency (in accordance with MIL-STD-130).

Legibility.

Criteria: Markings shall be readily readable. Color contrast between characters and surface shall be good. Markings shall be considered legible when each character can be easily identified, even if some of the print is faded or removed.

Pass____ Fail____

Permanency.

Criteria: Normal life expectancy of markings shall appear achievable. Markings shall be capable of withstanding the environmental tests and cleaning procedures. DUT shall be considered as permanently marked if markings remain legible after completion of qualification tests.

Pass____ Fail____

Color codes and bands.

Conformance to color code.

Criteria: Color code shall conform to limits of centroid colors in accordance with EIA-359 (use Munsel color chart book by Gretag Macbeth). During testing, colors shall remain within specified Munsel color limits from the centriod colors.

Pass____ Fail____

Fiber optic identification band for connectors.

Criteria: Connector shall be marking with either a yellow band or the words “Fiber Optics”.

Pass____ Fail____

Terminus TICC bands.

Criteria: Terminus shall contain 4 color coded bands or equivalent numbers, as specified in the fiber optic component military specification. Bands shall be color coded for the particular maximum ferrule hole diameter and body type. Color coding used shall conform to the following numbering scheme for the four TICC bands: 0 = black, 1 = brown, 2 = red, 3 = orange, 4 = yellow, 5 = green, 6 = blue, 7 = violet, 8 = gray, 9 = white.

Pass____ Fail____

Details on failures recorded:

MEASUREMENT 3105

VISUAL AND MECHANICAL INSPECTION

1. Purpose. This measurement intended to provide further direction for equipment, setup, processes, and evaluation criteria for ensuring that the visual and mechanical inspections performed after completion of environmental, mechanical, or material testing are done in a consistent manner and as specified in TIA-455-13. When performed at the start of a qualification, prior to fabrication of an assembled DUT, more quantitative size, weight, workmanship, and marking inspections (in accordance with measurements 3101, 3102, 3103, and 3104) are done in lieu of this measurement. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

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2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions

3.1 Visual and mechanical inspection. The visual and mechanical inspections performed either after or before and after completion of environmental, mechanical or material testing to qualitatively assess the degree or level of physical degradation to the DUT.

4. Setup. Measurement 3105 shall be conducted in accordance with the setup specified in TIA-455-13 with the restrictions specified in 4.1 through 4.4.

4.1 Placement in test order. The visual and mechanical inspections performed either after or before and after completion of environmental, mechanical, or material testing.

4.2 DUT disassembly. No disassembly shall be performed at the subcomponent level other than un-mating of connections and opening of covers/panels. No disassembly shall be performed that involves welded, riveted, bonded or otherwise mechanically or chemically affixed parts.

4.3 Special measurement equipment or devices. No special tools shall be used as part of this inspection to assess functionality of the DUT.

4.4 Measurement equipment. Unless otherwise specified, this visual inspection shall be done without magnification. As required, an optical magnifier may be used. Optical magnification for this inspection shall be limited to 3X to 5X.

5. Test procedure. Measurement 3105 shall be conducted in accordance with the methodology specified in TIA-455-13 with the restrictions for processes and evaluation criteria specified. Measurement processes shall include those summarized in 5.1 through 5.3. Pre and post exposure to test inspection shall check for: General construction, damage, missing parts, loose parts, finish imperfections, surface imperfections, part imperfections, inner part imperfections, cable imperfections, mateability, functionality, and installation. No optical magnification and no dimensional measurements are required for this inspection.

5.1 Inspections. Inspections performed on the DUT obtained as part of qualification shall include those listed in 5.1.1 through 5.1.12.

5.1.1 General design and construction. All form, fit, and function design features remain performing as designed.

5.1.2 Damage. No damage to parts occurred during shipping, testing, or standard cleaning.

5.1.3 Missing parts. All parts are included before and after completion of testing.

5.1.4 Loose parts. No loose inserts or other parts which adversely affect environmental sealing, permit cable sealant penetration, or degrade optical contact alignment.

5.1.5 Finish imperfections. No peeling or chipping of plating or finish, galling of wear, nicks, burrs, or other surface finish substandard blemishes or imperfections.

5.1.6 Surface imperfections. No rust, burnt areas, abrasions, holes, rough-head areas, bulges, thin spots, or indentations.

5.1.7 Part imperfections. Product/parts are dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces, inclusions, or other imperfections.

5.1.8 Inner part imperfections. Inner parts contain no fractures, holes, discontinuities, bulges, thin spots, or other imperfections.

5.1.9 Cabling imperfections. Cable parts, cables or strength members are not uniformly laid or have discontinuities. Fillers and water sealant are not uniformly distributed throughout the cable body.

5.1.10 Mateability. Connectors, adapters, and other interconnecting devices (mateable items) mate and unmate easily and make proper connection.

5.1.11 Functionality. Mechanical mechanisms function properly. Spring and latch mechanisms do not interfere with other components (cable fit into connector). Knobs, button, and threaded components operate properly.

5.1.12 Installation. Parts are assembled and seated properly.

5.2 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet shall include the contents illustrated in appendix A.

5.3 Performing mechanical workmanship inspections. When a sequence of tests are performed in which DUT assemblies are not to be unmated during the sequence (such as with the series of environmental testing), the mechanical inspections for workmanship shall not be performed as part of a visual examination of the DUT assembly.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3105

MEASUREMENT 3105

APPENDIX A

VISUAL AND MECHANICAL INSPECTION SAMPLE DATA SHEET

If a failure is recorded, provide details on the extent of the failure observed (on bottom on data sheet).

A.1. General design and construction.

Criteria: All form, fit, and function design features remain performing as designed.

Pass____ All design features affecting form, fit, and function are included. Component construction is substantial.

Fail____ Design feature is missing. Specify on data sheet.

____ Construction is not substantial. Specify on data sheet.

A.2. Damage.

Criteria: No damage to parts occurred during shipping, testing, or standard cleaning.

Pass____ No damage occurred.

Fail____ Damage occurred that affects form, fit, or function. Specify on data sheet.

A.3. Missing parts.

Criteria: All parts are included upon arrival for and after completion of testing.

Pass____ All parts included.

Fail____ Part(s) are missing. Specify on data sheet.

A.4. Identification markings and color.

a. Markings.

Criteria: All markings are present, of correct/minimum readable height, and of sufficient legibility and permanency.

Pass____ All markings are present, of correct/minimum readable height, and of sufficient legibility and permanency.

Fail____ All markings are not present. Specify on data sheet.

____ Height of markings is too small to read/distinguish characters. Specify on data sheet.

____ Markings are insufficiently legible (legible is if each character can be easily identified, even if some of the print is faded or removed). Specify on data sheet.

____ Markings are not permanent (permanent is if markings remain legible after completion of qualification test sequence). Specify on data sheet.

b. Color.

Criteria: Color is present and within correct shade.

Pass____ Color within specified shade.

____ No color requirement is specified.

Fail____ Color is outside of specified shades. Specify on data sheet.

A.5. Workmanship, visual.

a. Loose parts.

Criteria: No loose inserts or other parts which adversely effect environmental sealing, permit cable sealant penetration, or degrade optical contact alignment. Specify on data sheet.

Pass____ All parts included.

Fail____ Part(s) are missing. Specify on data sheet.

b. Finish imperfections.

Criteria: No peeling or chipping of plating or finish, galling of wear, nicks, burrs, or other surface finish substandard blemishes or imperfections.

Pass____ No finish imperfections observed that is detrimental to form, fit, or function or that could result in further protective coating or material degradation.

Fail____ Observed sufficient peeling or chipping of plating or finish, galling of wear, nicks, burrs, or other surface finish substandard blemishes or imperfections.

c. Surface imperfections.

Criteria: No rust, burnt areas, abrasions, holes, rough-head areas, bulges, thin spots, or indentations.

Pass____ No surface imperfections observed that are detrimental to form, fit, or function or that could result in further protective coating or material degradation.

Fail____ Observed sufficient rust, burnt areas, abrasions, holes, rough-head areas, bulges, thin spots, or indentations. Specify on data sheet.

d. Part imperfections.

Criteria: Product/parts are dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces, inclusions or other imperfections.

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Pass____ No part imperfections observed that are detrimental to form, fit or function or that could result in further protective material or function degradation

Fail____ Observed product/parts are not dimensionally uniform, free of lumps, kinks, splits, scraped or abraded surfaces, inclusions or other imperfections. Specify on data sheet.

e. Inner part imperfections.

Criteria: Inner parts contain no fractures, holes, discontinuities, bulges, thin spots or other imperfections.

Pass____ No inner part imperfections observed that are detrimental to form, fit or function or that could result in further material or function degradation

Fail____ Observed inner parts contain fractures, holes, discontinuities, bulges, thin spots or other imperfections. Specify on data sheet.

f. Cabling imperfections.

Criteria: Parts, Cables and strength members are not uniformly laid and/or have discontinuities. Fillers and water sealant are not uniformly distributed throughout the cable body.

Pass____ No cabling imperfections observed that are detrimental to form, fit or function or that could result in further material or function degradation.

Fail____ Observed, Parts Cables and strength members are not uniformly laid and/or have discontinuities. Specify on data sheet.

____ Observed fillers and water sealant are not uniformly distributed throughout the cable body. Specify on data sheet.

A.6. Workmanship, mechanical.

a. Mateability.

Criteria: Connectors, adapters, and other interconnecting devices (mateable items) mate and unmate easily and make proper connection.

Pass____ No mateability or other mechanical interconnects observed that are detrimental to form, fit or function or that could result in preventing mating.

Fail____ Connectors, adapters, and other interconnecting devices (mateable items) do not mate and unmate easily or do not make the proper connection. Specify on data sheet.

_____ Mateable items will not mate. Specify on data sheet.

____ Mateable items were damaged during mating. Specify on data sheet.

____ Mateable items did not make proper connection. Specify on data sheet.

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b. Functionality.

Criteria: Mechanical mechanisms function properly. Spring and latch mechanisms do not interfere with other components (cable fit into connector). Knobs, button, and threaded components operate properly.

Pass____ No mechanical mechanism malfunction observed that are detrimental to form, fit or function or that could result in further material or function degradation.

Fail____ Spring and latch mechanisms will interfere with other components (cable fit into connector). Specify on data sheet.

____ Knobs, button, and threaded components do not operate properly. Specify on data sheet.

c. Installation.

Criteria: Parts are assembled and seated properly.

Pass____ No observed parts that are assembled or seated in a manner that are detrimental to form, fit, or function or that could result in further material or function degradation.

Fail____ Improperly seated or assembled parts. Specify on data sheet.

Details on failures recorded:

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MECHANICAL MEASUREMENTS

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VIBRATION

1. Purpose. This measurement is performed when there is the requirement to subject the FOCT (fiber optic cable topology) component or device under test (DUT) to the stimulus of vibration. This measurement is intended to be used as part of qualification testing and is intended to supplement the applicable military standard (such as MIL-STD-167), commercial standard (such as TIA/EIA-455-11) or military specification (such as MIL-DTL-38999) for performing mechanical vibration testing on fiber optic components as specified in the applicable component military specification using a vibration machine that generates sinusoidal and random vibration environments. Further refinements or boundaries (constraints) are imposed in this measurement. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations, and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for.
MIL-DTL-38999	-	Connectors, Electrical, Circular, Miniature, High Density Quick Disconnect (Bayonet, Threaded and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.
MIL-C-83522	-	Connectors, Fiber Optic, Single Terminus, General Specification for.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-167-1	-	Mechanical Vibrations of Shipboard Equipment, (Type I - Environmental and Type II - Internally Excited.)

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVSEA DRAWING

8328898	-	Mechanical Splice, Fiber Optic, Aircraft, Test Sample Configurations/Fabrication and Specific Methods/Practices

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(A copy of this document can be obtained at web site: https://fiberoptics.nswc.navy.mil/ in the NAVSEA Drawing section under Component Information).

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA/EIA-455-11	-	Vibration Test Procedure for Fiber Optic Components and Cables.
TIA-455-20	-	Measurement Methods and Test Procedures-Monitoring of Changes in Optical Transmittance (IEC-60793-1-46 Optical Fibers Part 1-46)

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE International)

SAE-AS33671	-	Strap, Tiedown, Electrical Components, Adjustable Self-Cinching, Plastic, Type I, Class 1.

(Copies are available online at http://www.sae.org or can be obtained from the Society of Automotive Engineers (SAE International), 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definition

3.1 Vibration measurement. A test performed to determine the capability of an operational DUT when simulating the environment in which the DUT may be placed with sinusoidal and random vibration.

4. Test setup.

4.1 Methods to employ during vibration setup for connectors.

4.1.1 Test fixture integrity. The test fixture with a dummy load must be tested prior to fiber optic component qualification to verify no resonance occurs within the frequency range being tested.

4.1.2 Location of cable supports. The first set of cable supports after exiting the connector shall be located a minimum of 203.2 mm (8 inches) from the back end of a connector strain relief. NOTE: A set implies cable supports at each end of a connector mated pair.

4.1.3 Tension in cables exiting the connector. Portion of cabling exiting the connector and secured to the cable support is to be kept straight (such as parallel to the axial, versus radial, or direction of the connector) but allow up to 38.1 mm (1.5 inch) deflection or movement (deflect cable 38.1 mm (1.5 inch) from horizontal or straight run).

4.1.4 Isolated cable supports. The first set of cable supports after exiting the connector shall be isolated from (not affixed to) the vibration table.

4.1.5 External cable support structure. For large vibration machines where the table length exceeds the location where the first cable supports, an external cable support structure may be constructed. In one configuration, the first cable support may be affixed to the external cable support structure and suspended from above the vibration table. The external cable support structure must be isolated from the vibration table (machine).

4.1.6 Securing cable from DUT to cable supports. Cable that is exiting the connector is to be kept straight before placement onto the cable support. Cable may be secured to the cable support by means of tie wraps. Tie wraps are to be snug so that movement of the cable is restricted, but tie wrap exerts minimal to no pressure on the cables. If alternate means to secure the cables are used, this same restricted movement with minimal to no pressure on the cables is to be observed. For most applications, 101.6 mm (4-inch) long tie wraps may be used. SAE-AS33671 electrical tie down straps, adjustable, plastic, type I, class 1, miniature, 18 pound minimum tensile strength (such as P/N MS3367-4-9, NSN 5975-00-727-5153 or P/N MS3367-4-0, NSN 5957-00-903-2284) or other equivalent commercial self-locking cable ties.

4.1.7 Maintain minimum bend diameter. No cable bend is to exceed (be smaller than) the long term, minimum bend diameter of cable either at or after the cable support.

4.2 Test Instrumentation.

4.2.1 Optical signal discontinuity. Monitor a minimum of four channels per DUT for optical signal discontinuity during the test.

4.2.2 Change in optical transmittance. Monitor all DUT channels for change in optical transmittance before and after each test condition.

4.2.3 Instrumentation used. Refer to MIL-STD-1678-2 Measurements 2102 and 2104 for setups pertaining to change in optical transmittance and to optical signal discontinuity, respectively.

4.2.4 Vibration isolation. Ensure that optical equipment is isolated from vibration. Surface vibration can affect instrumentation and connections at the optical ports. One method for isolation is to place optical instrumentation on foam pads or other type of resilient surface.

4.2.5 Accelerometer setup.

a. Orient accelerometer so it is mounted along the 3 principal axes of the DUT.

b. Stud mounting accelerometer to supplemental fixture is preferred mounting method. Mount accelerometer to fixture using supplied mounting studs or supplied screws (such as Allen head cap screws). When used, tighten Allen head cap screws to torque specified on the accelerometer parameter sheet.

c. Clean microdot connector signal pins using isopropyl alcohol. Connect one end to the appropriate accelerometer for axis under test. Connect the remaining end to the charge amp input.

d. Connect the accelerometer amplifier BNC output to the data acquisition interface box using suitable BNC-BNC cable. Connect to appropriate data acquisition channel.

e. Set the amplifier sensitivity and set amplifier settings to provide a recording capability at 80 percent of the data acquisition card range.

f. Set the lower frequency limit at 2 Hz or as applicable.

g. Set the upper frequency limit at 1 kHz or as applicable.

h. Move power switch to “On”.

i. Verify that batteries, if used, are charged. Replace or recharge batteries as required.

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4.2.6 Data acquisition setup for accelerometer measurement. Ensure acceptable optical signal trace by verifying that no saturation of the optical trace has occurred. Flat horizontal lines in the signal trace close to the baseline (0 dB) or close to optical signal peaks is an indication of amplifier saturation. For example, using a -10 volt to +10 volt signal, a data acquisition board would clip (become saturated) at ±10 volts. A flat line signal is a voltage level greater than +10 volts or less than –10 volts and is beyond the capability of the data acquisition system to measure it.

4.2.7 Accelerometer calibration. The accelerometer shall be calibrated to at least ± 5 percent over the frequency range of 5 to 2,000 Hz.

4.2.8 Accelerometer selection. The accelerometer selected for a vibration sensor should have a fundamental resonant frequency that is not less than 10,000 Hz.

4.2.9 Accelerometer placement. The accelerometer shall be rigidly secured and located on the test fixture foundation as near as possible to the DUT, but not on the DUT itself.

4.3 Torque. For multiple termini connectors with coupling rings, apply specified torque and mark position as indicated below.

4.3.1 Applying torque. Prior to testing, initial mate and apply specified torque value.

4.3.2 Marking coupling ring position. Mark position after torque applied and check/record position after each axis.

NOTE: The performance of the connector assembly is based upon the dimensions that exist with the connector tightened properly and the mating components completely seated. This is especially true in connectors that use spring loaded inserts and elastic environmental seals/gaskets that must be properly preloaded/pre-stressed to function according to design parameters. Either the tightening torque should be specified, a final dimension or check mark established, or the connector tightened until no free play exists between the receptacle and the plug portion. Since the condition of "no free play' is somewhat indefinable and usually no marks are provided, the tightening torque specified for the connector must be used. The marking is also critical in determining if the change in measured performance is caused by the connector becoming loose. Vibration is a mechanical test and the energy imparted should not create any movement in any of the connector components, which could degrade the optical performance of the assembly (including loosening). Usually, accelerometers or other instrumentation is used to determine the response of items under test, however, due to the size and shape of connectors this is difficult to accomplish. Visual observation of alignment marks is an easy and efficient method to determine if the impact is causing an undesirable condition. Consideration should be given to identifying/specifying the amount of looseness that is acceptable. Ideally there should be no loosening whatsoever.

4.3.3 Connectors with ratchet mechanism. For a mating connector containing a coupling ring ratchet mechanism or where specified for a particular connector type, do not tighten during testing.

4.3.4 MIL-PRF-28876 connectors. Verify that DUT is sufficiently tight. When mated initially by hand tighten, do not bottom out threads prior to applying torque. Apply torque as specified in the table 3201-I. Verify/apply the torque after each axis. Mark position after torque applied and check/record position after each axis.

TABLE 3201-I. MIL-PRF-28876 coupling nut torque requirements.

Shell size	11	13	15	23
Torque (in-lb)	15	15	25	50

4.3.5 MIL-C-38999 connectors. Initially mate and apply a torque. For shell size 11 (2 termini connector), apply a torque of 1.4 N-m (12 in-lb). Mark position after torque applied and check/record position after each impact. Mating halves contain a ratchet mechanism. Do not tighten after each axis.

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4.3.6 Verify mating parts retained on single ferruled connectors. For MIL-C-83522 connectors, COTS ST, LC and SC connectors, verify that the adapters are adequately tightened/fastened to the patch panel. Verify that DUT is sufficiently tight and did not become disconnected/loose after each impact.

4.4 Test fixture.

4.4.1 Test fixture integrity. Prior to performing the measurement, the test fixture with a dummy load must be tested prior to fiber optic component qualification to verify no resonance occurs within the frequency range being tested.

4.4.2 Securing DUT assembly cabling. Securing of cabling shall be performed as specified in 4.1.2 through 4.1.7.

4.4.3 Test fixture for mechanical splices, aircraft applications. Test fixture shall conform to requirements and configuration as specified in NAVSEA Drawing 8328898.

5. Test procedure. Unless otherwise specified, measurement shall be performed in accordance with 5.1 (see MIL-STD-167 part 1) specifically for a shipboard application, performed in accordance with 5.2 (TIA/EIA-455-11) for general applications, and performed in accordance with 5.3 for aircraft applications. General measurement processes that shall be implemented are specified in 5.4 through 5.8.

5.1 Test condition A synopsis, testing performed in accordance with MIL-STD-167-1. Use for a DUT specified specifically for a shipboard application (such as a MIL-I-24728/1 interconnection box).

a. Perform type I exploratory vibration test (front cover off during test):

   (1) Frequency range with amplitude: 4 Hz to 33 Hz at 0.25 mm ±0.05 mm (.010 ±.002 inch).

   (2) Frequency range with amplitude: 34 Hz to 50 Hz at 0.08 mm ±0.24 mm (.003 ±.001 inch).

   (3) Discrete frequency interval: 1 Hz.

   (4) Duration at each frequency: 15 seconds minimum.

b. Perform type I variable frequency test (front cover on during test, remove after test to inspect for damage):

   (1) Frequency range with amplitude: 4 Hz to 50 Hz at amplitudes in accordance with table I of MIL-STD-167-1.

   (2) Discrete frequency interval: 1 Hz.

   (3) Duration at each frequency: 5 minutes minimum.

c. Perform type I endurance test (front cover on during test, remove after test to inspect for damage):

   (1) If resonance frequency(s) occurred: At least 2 hours at each resonance frequency chosen by test engineer.

   (2) If resonance frequency did not occur: Test at 50 Hz at amplitude of 0.07 mm +0.00/-0.03 mm (.003 inch +.000/-.001 inch) for minimum of 2 hours.

d. Repeat for other two orthogonal axes (vertical, side-to-side, front-to-back).

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5.2 Test condition B synopsis testing performed in accordance with TIA/EIA-455-11. Unless otherwise specified, use test conditions II and VII for multiple termini connectors, test conditions III and VII for single ferrule connectors.

a. Perform test condition II (swept sine) 10 Hz to 500 Hz (except extend low limit to 5 Hz) where:

(1) Amplitude: 1.52 mm (.06 inch) double amplitude or 10 g peak, whichever is less.

(2) Tolerance: ±10 percent on vibration amplitude.

(3) Frequency range: Vary logarithmically between 5 Hz and 500 Hz.

(4) Sweep time: 15 minutes per cycle (9 hours total).

(5) Number of cycles: 12 times on each of 3 mutually perpendicular directions for 36 times.

b. Perform test condition III (swept sine) 10 Hz to 2000 Hz (except extend low limit to 5 Hz) where:

(1) Amplitude: 1.52 mm (.06 inch) double amplitude or 10g peak (versus 15 g peak), whichever is less.

(2) Tolerance: ±10 percent on vibration amplitude.

(3) Frequency range: Vary logarithmically between 10 Hz and 2,000 Hz except test condition I procedure may be applied between 10 Hz to 55 Hz (with duration for this 10 Hz to 55 Hz range of approximately 1.33 hours in each axis for the test condition I procedure).

(4) Sweep time: 20 minutes per cycle (12 hours total).

(5) No. of cycles: 12 times on each of 3 mutually perpendicular directions for 36 times.

c. Perform TIA test condition VII and letter C (random) 50 Hz to 2,000 Hz envelope where:

(1) C = 0.06 power spectral density, 10.2 overall RMS G.

(2) Vibration envelope: See figure 3 of TIA/EIA-455-11.

(3) Duration: 1.5 hour (30 minutes per axis).

5.3 Test condition C synopsis, testing performed on a DUT used in an aircraft environment. Perform the sine vibration test and the two random vibration tests.

a. Sine (sinusoidal or swept sine) vibration in accordance TIA/EIA-455-11, test condition III, tailored using the vibration input (amplitude) versus frequency range in table 3201-II and modified durations specified herein. Vibration shall be performed at ambient temperature only. This cycle shall be performed 12 times in each of three mutually perpendicular directions at ambient temperature. This results in a total of 36 cycles being applied for approximately 12 hours. The sequence shall be repeated twice. (36 hours total at ambient temperature). Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before proceeding to the next band.

TABLE 3201-II. Sine vibration parameter inputs.

Frequency range	Vibration input
10 – 50 Hz	254 mm/sec
50 – 140 Hz	1.5 mm double amplitude
140 – 2,000 Hz	60 G

b. Random vibration in accordance with TIA/EIA-455-11, test condition VII, letter "J". Duration shall be 8 hours in the longitudinal direction (orientation parallel to the optical fiber length and designated at the z axis) and 8 hours in the radial or transverse direction (orientation parallel to the optical fiber end cross section and in the x-y plane) for a total of 16 hours. Vibration shall be done at a temperature of 125°C. Calculated overall Grms value from vibration machine controller shall be provided.

c. Random vibration in accordance with TIA/EIA-455-11, test condition VI, tailored using the power spectral density versus frequency curve in accordance with MIL-DTL-38999, figure 25 which starts at 25 Hz. Duration shall be 8 hours in the longitudinal direction (orientation parallel to the optical fiber length and designated at the z axis) and 8 hours in the radial direction (orientation parallel to the optical fiber end cross section and in the x-y plane) for a total of 16 hours. Vibration shall be done at ambient temperature. Calculated overall Grms value from vibration machine controller shall be provided.

5.4 Panel removal during testing. Below is a synopsis of purpose while expounding on requirement for testing with an enclosure panel(s) on (in place) or off (removed). One application is for testing a fiber optic interconnection box (FOICB) with front cover on/off. This synopsis is written for performing the vibration test in accordance with MIL-STD-167-1 where this swept sine testing is done in three parts (Exploratory, variable frequency, and endurance). For tests (such as TIA/EIA-455-11) where each test condition (either swept sine, random or both) is done in one part, testing is to be performed using the guidance for panel placement under variable frequency.

5.4.1 Exploratory. Purpose is to identify frequencies at which resonance occurs to test at these frequencies in the endurance test. No damage is expected. Perform with panel(s) off to observe if there is any resonant activity of the test items. Purpose is to perform a quick-look preliminary sweep to identify critical frequencies. Corrective measures or specific instrumentation can be implemented before proceeding to the variable frequency and endurance tests.

5.4.2 Variable frequency. Purpose is to verify that DUT performance is maintained with no detrimental effects at each different frequency. The duration of 5 minutes allows performance checks/inspections to be accomplished. The DUT must be able to perform its intended function in the presence of the specified vibration without any basic failure (such as fatigue/overstress damage) or degraded performance. Perform this test with the panel(s) on. Remove cover after variable frequency test in each axis to inspect for damage before continuing with endurance test.

5.4.3 Endurance. Purpose is to test at each resonance frequency at 2 hours per frequency or the maximum test frequency for 2 hours if no resonances are observed to ensure that no damage or performance degradation occurs. Perform this test with the cover on. Remove cover after endurance test in each axis to inspect for damage.

5.5 Optical measurements.

5.5.1 Change in optical transmittance.

5.5.1.1 Method. The change in optical transmittance shall be measured during and after the test (from a baseline obtained before each test) in accordance with TIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in MIL-STD-1678-2 Measurement 2102.

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5.5.1.2 Optical instrumentation capacity. This optical monitoring assumes that an optical measurement system is available with a sufficient channel measurement capability and that only one optical source exists that requires only one monitoring channel (to monitor and compensate for optical source drift).

5.5.1.3 Calculated parameters. Change in optical transmittance or the logarithmic power ratio of DUT post measurement relative to pre-impact measurement. The computation is as follows: Log (dB) = 10 log [(Pt_i/Pt_o].

Where: Pt_o = Power transmission of item under test measured before start of test.

Pt_i = Power transmission of item under test measured after axis/test.

Pt_i/Pt_o = Relative change in power transmission of the item under test after axis/test.

5.5.2 Optical signal discontinuity.

5.5.2.1 Recorded parameters: Recorded parameters are to include the maximum change in optical transmittance during discontinuity interval (dB), and the time duration of discontinuity (microseconds).

NOTE: Record, at a minimum, the discontinuity with the maximum duration in with the change in optical transmittance exceeds 0.5 dB (if any). Also record the corresponding maximum value of the change in optical transmittance for the discontinuity with the maximum duration.

5.5.2.2 Calculated parameters. Optical signal discontinuity after each event (ΔD) = 10 log (Pti/Pt_0) where:

Pt_0 = Power transmission of test fiber measured before start of the event.

Pti = Power transmission of test fiber measured after the event.

(Pti/Pt_0) = relative change in power transmission of test fiber after event.

NOTE: Record an increase in optical transmittance (increasing power) as a positive (+) dB.

5.6 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet is to list the items in 5.6a through 5.6c.

a. Test apparatus shall include the vibration machine and type of mounting fixture (such as mounting plates, if any, used to secure the DUT to the test fixture, mounting plate used to secure the test fixture to the vibration machine).

b. Axis/direction, amplitude and frequency range/band plus any additional descriptive test item data (such as damage occurred, specific frequency, resonance or both that occurred at a specific frequency).

c. Test tolerances for the following optical signal discontinuity parameters: Maximum allowed change in optical transmittance (signal level) during shock pulse in dB, maximum allowed time duration of optical signal discontinuity in microseconds, and maximum allowed relative change in optical transmittance before/after an event in dB.

5.7 Post test visual examination.

5.7.1 Physical deterioration. Evidence of any of the following defects after the test shall be cause for failure of the DUT:

a. Broken or excessively worn engaging hardware.

b Uneven wear or galling of hardware, guide pins, or mating surfaces.

c Excessive debris from worn surfaces.

d. Damage or wear to seals, if applicable.

e. Displaced, bent, broken, or chipped parts.

f. Scratching of the interface area.

g. Leaking of filling of potting compounds.

h. Relative motion between cable and connector/splice parts.

i. Physical distortion/wear resulting in fatigue or failure.

j. Separation of bonded surfaces.

k. Unless otherwise specified, connectors shall not exhibit loosening of parts for the range of frequencies tested.

NOTE: Minor physical damage to the tested item, such as small cracks, minor yielding of structure, out-of tolerance clearances, and similar damage may not be cause for vibration test disapproval if such damage is accepted by the Defense Supply Center Columbus (DSCC VQP) and unless such damage causes unacceptable impairment of equipment performance, results in a hazard, or results in substantially shortened equipment useful life.

5.7.2 Optical performance.

a. Maximum allowed change (discontinuity) in optical signal amplitude during vibration (in dB).

b. Maximum allowed duration of optical signal discontinuity for multimode DUT/channels.

c. Maximum allowed duration of optical signal discontinuity for single mode DUT/channels.

d. Maximum allowed change in optical transmittance after each test condition (in dB).

5.7.3 Mechanical deterioration. Inability of the launch or detector connectors to properly mate and un-mate during or after the completion of the test shall be cause for failure of the DUT.

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5.8 Safety. Safety items include, but are not limited to, the following:

a. Post sign stating “VIBRATION TEST IN PROGRESS” where appropriate.

b. Verify all personnel in the facility are wearing their ear protection in a proper manner.

c. Inspect setup to ensure that torque on applicable bolts is to proper values and mechanical components are locked/in proper position prior to performing the test.

5.9 Verification. The checklist in appendix A is provided to ensure compliance for inspection purposes.

5.10 Test interruptions. Test must be continued as specified in accordance with 4.3.1 herein if interruption exceeds 1 hour.

5.11 Contamination. When test samples are comprised of connectors or termini, the ferrule end face of each connector/termini mated pair shall be inspected for cleanliness after the completion of the test or during specified points during and after the completion of the test, as specified. Inspection shall be performed using a Fiber Optic Video Inspection System (FOVIS). As an option, each end face shall be captured using software provided with the FOVIS. For each cleaning operation performed, a table is requested to summarize the number of cleaning steps, cleaning device, cycle used, and result.

6. Notes.

6.1 Intended use, qualification testing. Stresses are applied to simulate conditions over an in-service condition and that under the stresses to show compliance with specification requirements.

APPENDIX A

MINIMUM ESSENTIAL CHECKLIST FOR VIBRATION MEASUREMENTS

A.1. Purpose. This appendix addresses a checklist of the minimum essentials for the vibration measurement.

A.2. Usage. Table 3201A-I is the checklist of minimum essentials for Government auditors, or their representatives, use during inspections. This checklist should be expanded at the auditor's discretion.

TABLE 3201A-I. Minimum essential checklist for vibration measurements.

Item	Category	Description	Requirement	Compliance
1	Test sample configuration	Cable assembly length: Connectors and splices	10 meters minimum (13 m if to do 3 cut-backs)	
		Other fiber optic components: see MIL-STD-1678-4	Complies with MIL-STD-1678-4	
2	Room ambient Environmental condition	Standard ambient (if test equipment built to operate in this range, if not-then controlled ambient)	23°C ±5°C/73°F ± 9°F and 20% to 70% RH	
		Controlled ambient	23°C ±2°C/73°F ±4°F and 45% to 55% RH	
3	Test condition	Test setup cable routing	Bend diameters ≥ min long term bend dia	
			Sharp twists and bends avoided	
			Avoid protrusions/other obstacles	
4	Vibration measurement	Accelerometer parameters	Calibration: ±5 percent over the frequency range of 5 to 2,000 Hz	
			Selection: fundamental resonant frequency ≤ 10,000 Hz.	
			Placement: Secured rigidly (stud mounted preferred), on test fixture foundation, near as possible to, but not on DUT	
			Orientation: along 3 principle axes of DUT	
			Connect instrument cabling: Clean connections, select suitable cable (such as BNC-BNC cable)	
			Verify proper amplifier sensitivity set for accelerometer used	

TABLE 3201A-I. Minimum essential checklist for vibration measurements - Continued.

Item	Category	Description	Requirement	Compliance
	Test equipment			
5	Vibration test (Use test conditions A, B, or C)	MIL-STD-167 type (Test condition A)	Perform type I exploratory, type I variable frequency, type I endurance (see 5.1)	
		TIA/EIA-455-11 type (Test condition B)	Perform test conditions II (swept sine) and VII (random) or III (swept sine) and VII, as specified (see 5.2).	
		Aircraft applications (Test condition C)	Perform sine, random at elevated temperature, random at ambient (see 5.3)	
6	Optical measurements	Change in optical transmittance	Compliance with measurement 2101 of MIL-STD-1678-2	
7	Examinations	Visual inspection	No leakage, loss of sealing capacity, damage detrimental to operation	
		Ferrule end face contamination	FOVIS inspected and cleaned. Table provided summarizing cleaning steps, cleaning device, cycle used, and result	
		Optical fiber connections	Routed outside chamber or to an optical interface port at chamber wall	
9	Test setup	Test fixture validation	Pre-qualification test, fixture tested with dummy load to verify no resonances occur within frequency range being tested	
		Cabling supports	First at ≥ 203.2 mm (8 inch) from DUT assembly, isolated from vibration table	
			Cable taunt with up to 38.1 mm (1.5 inch) deflection, at bends do not exceeded minimum bend diameter	
			Secure/tie down cables (tie wraps allowed/make snug)	
		Data acquisition setup	Verify no amplifier saturation occurs (see 4.2.6)	
		Torque	Applies to non-aircraft, multiple termini connectors (see 4.3)	
		Test processes	Compliance with measurement 3201	

MEASUREMENT 3201

TABLE 3201A-I. Minimum essential checklist for vibration measurements - Continued.

Item	Category	Description	Requirement	Compliance
10	Test	Maintain setup during test (source end)	No disconnection allowed until after testing completed (see MIL-STD-1678-2 measurements 2102 and 2104)	
		Number of channels monitored	Optical signal discontinuity: ≥4 Change in optical transmittance: all (before and after each test condition)	
		Panel removal during testing (see 5.4)	Applicable type DUT include interconnection boxes	
			Exploratory: Cover (panel) off	
			Variable frequency: on during test, off each axis to inspect	
			Endurance: on during test, off each axis to inspect	
11	Calculation	Operator performed calculations	Verify correct method used and calculated properly (see 5.5)	
		Approved data sheet	Compliance with MIL-STD-1678-2 measurement 2201	
12	Data sheet	Added data sheet requirement	Test apparatus includes: Vibration machine Mounting fixture Mounting plates	
			Test parameters and limits axis/direction amplitude frequency range/band any descriptive test data (see 5.6b)	
			Test tolerances for the following optical signal discontinuity parameters: Maximum allowed change in optical transmittance (signal level) during shock pulse in dB Maximum allowed time duration of optical signal discontinuity in microseconds, Maximum allowed relative change in optical transmittance before/after impact in dB	
			If connector, was DUT mated or unmated	

MEASUREMENT 3201

TABLE 3201A-I. Minimum essential checklist for vibration measurements - Continued.

Item	Category	Description	Requirement	Compliance
12	Data sheet - continued	Post test visual examination for physical deterioration	Broken or excessively worn engaging hardware. Uneven wear or galling of hardware, guide pins, or mating surfaces. Excessive debris from worn surfaces. Damage or wear to seals, if applicable. Displaced, bent, broken, or chipped parts. Scratching of the interface area. Leaking of filling of potting compounds. Relative motion between cable and connector/splice parts. Physical distortion/wear resulting in fatigue or failure. Separation of bonded surfaces. Connectors shall not exhibit loosening of parts for the range of frequencies tested (unless otherwise specified).	
		Post test visual examination for mechanical deterioration	Connectors: Ability of the launch or detector connectors to properly mate and un-mate during or after the completion of the test. Other: Ability to operate mechanical items, install and remove panels.	
13	Pass/fail criteria	Proper criteria implemented	Test operators know if fail and to verify result	

A.3. Notes.

A.3.1 Intended use.

A.3.1.1 Audit team. This checklist is intended to assist Government auditors or their representatives during inspections of the optical measurement system. This checklist may be augmented at the auditor's discretion; however, it is not to be reduced.

A.3.1.2 Test laboratories. When test laboratories prepare to perform vibration measurements or audits, this checklist should be used to supplement measurement 3201, not replace it.

MEASUREMENT 3202

SHOCK (MECHANICAL)

1. Purpose. This measurement intended to supplement MIL-S-901 for performing high impact mechanical shock testing on fiber optic components as specified in the applicable component military specification (see below) using the MIL-S-901 lightweight shock machine. Primarily addressed is testing at the level of a subsidiary component (type B) for fiber optic components; however, aspects for test guidance/requirements on principal units (type A) is included also. Shock testing of a fiber optic component to the applicable component military specification as part of the process of placing a component on a Qualified Products List (QPL) is considered as testing at the subsidiary component level by the Navy Shock Qualification Activity. Shock testing of a fiber optic component at the level of a subsidiary component is done for the purpose of providing reasonable assurance that the fiber optic component will also pass subsequent type A tests (when tested as a part of one or more principal units) and to improve opportunities for shock test extension. To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-S-901 - Shock Tests H.I. (High-impact) Shipboard Machinery, Equipment, and Systems, Requirements for.

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVY SHIPBOARD FIBER OPTICS

- Mechanical Shock (Hi-Impact) Test and Measurement Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 965/002 of 02 September 2006

(A copy of the Mechanical Shock (HI-Impact) Test and Measurement Guide can be obtained at Web Site: https://fiberoptics.nswc.navy.mil/ in the Policy and Guidance section under Testing Information. If unable to access this Web Site, request an application by e-mail to NSWC DD Warfare Systems Department at DLGR_NSWC_Foweb@navy.mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions

3.1 Equipment class. This classification defines if the resilient mounts are installed between the DUT and the ship structure or shipboard foundation.

3.2 Equipment “class I”. Class I equipment meets the shock requirements without the use of resilient mountings (between the DUT and the ship structure or shipboard foundation). Class II equipment meets the shock requirements with the use of resilient mountings.

3.3 Equipment “class II”. Class III equipment meets the shock requirements with and without the use of resilient mountings (thereby required to meet both class I and class II requirements). Unless otherwise specified, fiber optic components are considered as class I equipment.

3.4 Shock grade. This classification defines the degree that the DUT must remain intact and function after receiving a mechanical shock.

3.5 Shock “grade A”. Operation of the DUT is essential to the safety and continued combat capability of the ship. The requirements for the pass/fail criteria specified above are to meet grade A. In general, shock testing or design of a grade A DUT shall demonstrate that the DUT will continue to perform its principal function without significant degradation in performance, and that no portion of the DUT will come adrift or otherwise become a hazard during and following application of shock loadings.

3.6 Shock “grade B”. Exposure of the DUT to shock cannot result in a missile hazard to personnel or to the ship as a whole. In general, grade B items are items whose operation is not essential to the safety and combat capability of the ship but which could become a hazard to personnel, to grade A items, or to the ship as a whole as a result of exposure to shock. Failure of a grade B item to perform its principal function after shock shall not be cause for rejection.

3.7 Shock test categories. Test category refers to the type of shock machine or platform in which the test is done. Unless otherwise specified, a lightweight test is performed (on a lightweight shock machine) in accordance with MIL-S-901 for testing of fiber optic components. Other categories are medium weight (using a medium weight shock machine) and heavyweight (using a floating shock platform). Measurement 3202 is written on the premise that a lightweight test is performed. Size, weight, and deflection constraints may negate being allowed to perform a lightweight shock test. See items under test equipment for further guidance on this matter.

3.8 Shock test type. This classification identifies if the DUT is a principal unit, a subsidiary component or a subassembly of a principal unit or subsidiary component. Fiber optic components, as tested for the applicable component military specifications, are as considered subsidiary components (Type B test) by the Navy Shock Qualification Activity. MIL-S-901 shock testing of principal units must be coordinated through and approved by the Navy Shock Qualification Approval Activity.

3.9 Shock test “Type A”. The type A test is a test of a principal unit. Principal units are directly attached to the ship structure or mounted in systems (such as piping and ducting) that are supported by the ship structure.

3.10 Shock test “Type B”. The Type B test is a test of a subsidiary component. Subsidiary components are items that are the major parts of a principal unit.

3.11 Shock test “Type C”. The Type C test is a test of a subassembly. Subassemblies are items that are a part of a principal unit or a subsidiary component.

4. Measurement. The DUT shall be measured (tested) for effects of shock impact as specified in the component military specification with further constrains cited in Mechanical Shock (Hi-Impact) Test and Measurement Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 965/002 of 02 September 2006.

5. Implementation. Measurement 3202 shall be conducted in accordance with the methodology specified in Mechanical Shock (Hi-Impact) Test and Measurement Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 965/002 of 02 September 2006. The test methodology employed in evaluating the effects of the shocks shall include setup and procedure as summarized in 5.1 and 5.2. Specified data shall be provided on the data sheet. Specified parameters shall be documented in the test report.

5.1 Setup. The test setup shall include use of test fixture for connectors and cabling specified listed in the applicable figure in Mechanical Shock (Hi-Impact) Test and Measurement Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 965/002 of 02 September 2006; and the properly specified mounting, torque, and measurement equipment.

5.2 Procedure. Test methodology shall include specified accelerometer usage and analysis.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3203

CABLE SCRAPING RESISTANCE

1. Purpose. This measurement is intended to provide further direction for equipment, setup, processes, and evaluation criteria for ensuring that the measurement 3203 for cable scraping resistance is done in a consistent manner. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-24640 - Cables, Light Weight, Electric, Low Smoke, for Shipboard Use, General Specification for.

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

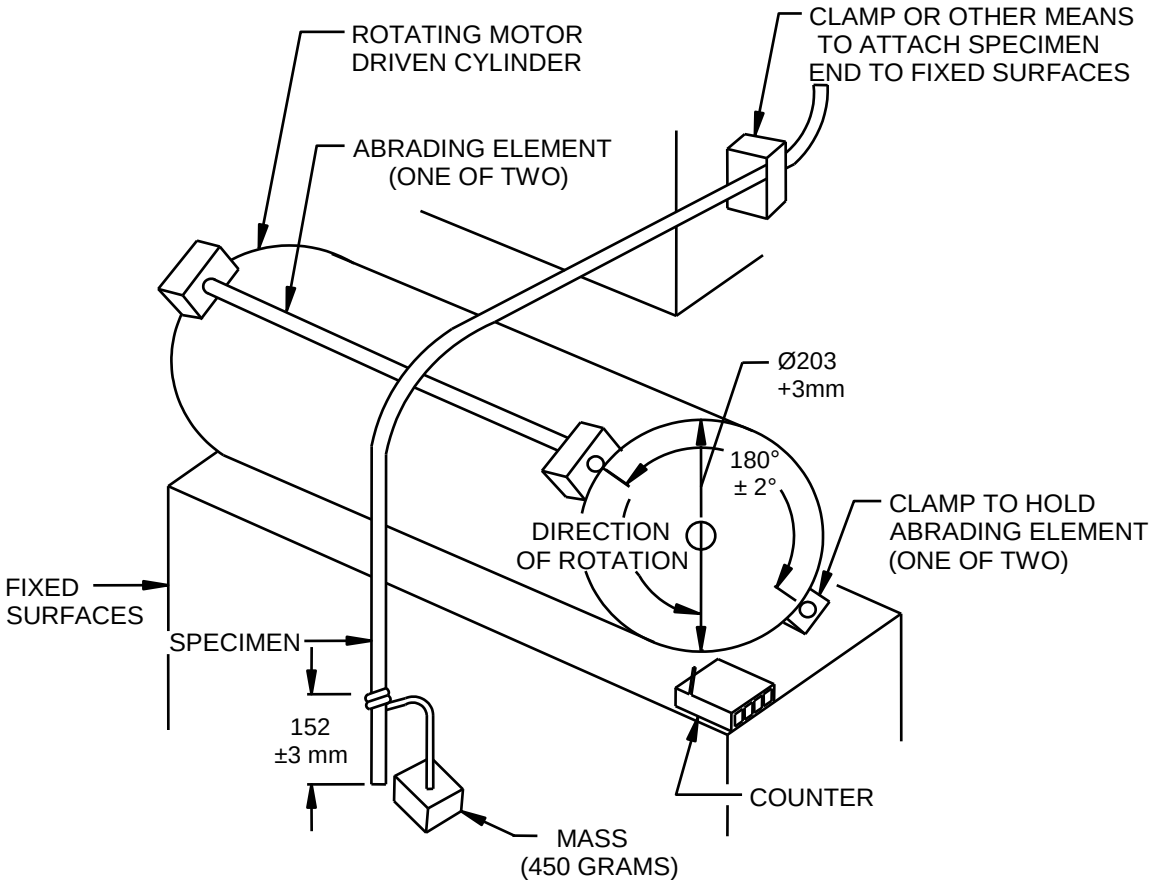
2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Scraping resistance. A measurement performed to determine the ability of the cable jacket material to withstand a scraping type wear or damage induced by mechanical means using a sharp hard surface.

4. Setup. Measurement 3203 shall be conducted in accordance with the setup restrictions specified in 4.1 through 4.10.

4.1 Test apparatus. The test apparatus shall hold the test specimen firmly clamped in a horizontal position with the outer longitudinal surface of the DUT fully exposed. The test apparatus shall rub an edge (a drum with an abrading edge, or equivalent, as shown in figure 3203-1 shall be used) repeatedly over the outer surface of the specimen in such a position that the longitudinal axis of the edge and the specimen are at right angles to each other with the edge and outer surface of the DUT in contact. The clamped end of the cable shall be positioned such that the scraping surface (abrading element) abrades the cable for the length specified. The scraping surface shall consist of high speed tool bits which have been ground on two adjacent longitudinal sides to produce a single, sharp 90 degree longitudinal edge, free of visible nicks. A test weight affixed to the DUT as shown in figure 3203-1 shall control the force exerted normal to the surface of the jacket material. A motor-driven, reciprocating cam mechanism shall be used to deliver an accurate number of abrading strokes in a direction parallel to the longitudinal axis of the DUT. The number of cycles shall be measured by a counter. The length of the stroke shall be 5 cm and the frequency of the stroke shall be 30 cycles (60 strokes) per minute.



NOTES:
1. The length from the top center of the rotating cylinder to the end of the cable specimen to which the weight is attached shall be a minimum of 762 mm (30 inches).
2. The bottom edge of the clamped specimen shall be level with the top surface of the rotating cylinder.

FIGURE 3203-1. Scraping abrasion test apparatus

MEASUREMENT 3203

4.2 Measurement equipment.

4.2.1 Weight measurements. Measurement equipment (scale or balance) accuracy shall be ±5 percent of span. Measurement equipment shall be within 10 to 90 percent of the range and have sufficient resolution to obtain measurement to within specified accuracy.

4.2.2 Dimensional measurements. Unless otherwise specified, measurement equipment (instrument or tool) accuracy shall be ±0.02 mm (±.001 inch).

4.2.3 Frequency measurements. Measurement equipment accuracy shall be ±0.2 Hz. Measurement equipment shall have a resolution of 0.5 Hz.

4.2.4 Elapsed cycle measurements (counter). Measurement equipment shall at a minimum measure and display a count of 1,000 cycles.

4.3 Test weight. Verify acceptability of 454 gm (1 lb) weight on scale. Ensure weight is between 450 gm to 458 gm (0.99 pound and 1.01 pound).

4.4 Inspect scraping surface and replace if not suitable.

a. Verify that the scraping surface has a single sharp edge by observing if there are any flat spots (reflections of light).

b. Verify that scraping surfaces are free of visible nicks.

c. Verify that scraping surfaces will not exceed 7,500 cycles during test.

d. Scraping surfaces used shall be a high speed tool bit that conforms to 4.7.1.2 of MIL-DTL-24640.

e. Scraping surfaces shall be reground as required or after a maximum of 5 hours of use as specified in 4.7.1.2 of MIL-DTL-24640.

f. Scraping surfaces shall be replaced whenever the perpendicular distance between either pair of opposite longitudinal sides of an abrading element becomes less than 7.836 mm (.3085 inch).

4.5 Set frequency counter and drum rotation:

DANGER:
Rotating drum - no safety break.
Keep hands and loose clothing clear.

a. Turn on scraping abrasion test apparatus and frequency counter.

b. Allow the frequency counter to gate several times before attempting to adjust speed control.

c, If no value appears, ensure cables are connected correctly, power is on, then slowly adjust sensing level and gating delays until a value appears on the counter.

d. Slowly adjust speed control knob on back of scrapping abrasion test apparatus obtaining a value as close as possible to 0.5 Hz (frequency at 30 cycles/minute) on frequency counter display.

e. Turn off scraping abrasion test apparatus.

4.6 Prepare sample cables. ALL MEASUREMENTS ARE MADE FROM END WHERE WEIGHT WILL HANG.

a. Cut a 1067 mm (42 inch) long sample of cable.

b. Measure up 76.2 cm (30 inches) from cable end and mark cable

c. Place three more marks on cable 25.4 mm (1 inch) apart back towards the end you measured from. This will place marks at 68.58 cm, 71.12 cm, 73.66 cm and 76.2 cm (27 inches, 28 inches, 29 inches, and 30 inches.) These marks should ring the cable and not rub off with just simple contact.

d. Move cable down 20.3 cm (8 inches) and place marks at 48.26 cm, 50.80 cm, 53.34 cm, and 55.88 cm (19 inches, 20 inches, 21 inches, and 22 inches).

e. Prepare all samples to be tested.

4.7 Mount cable and test weight to scraping abrasion test apparatus.

a. Mount cable. The 76 cm (30 inch) mark should be centered directly above the top center of scraping drum, and clamped into place.

b. Mount test weight. Using about a 17.78 cm (7 inches) long section of string, tie one end to 1 pound weight and other end of the string 15.24 cm (6 inches) up from end of cable. Place tape at tie point of string and cable to prevent slippage of the weight (see figure 3203-1). Dampening material may be placed near test weight to minimize swing (but shall not add to the mass of the test weight).

4.8 Measure cable diameter.

a. Use a ratchet style micrometer or other suitable measurement equipment.

b. Measure the diameter of the cable, at the first set of marked rings and record.

c. The diameter before and after abrasion is being sought so the measurement must be made with one end of the micrometer on the surface to be abraded.

4.9 Initialize counter. Set stroke counter on scraping abrasion test apparatus to zero.

4.10 Capture/confine cable scrapings. Place trash can under cable to catch cable scrapings. Ensure that test weight is not in contact with sides of trash can.

5. Test procedure. The DUT shall be clamped in the test apparatus and a mass of 0.45 kg (.99 lb) shall be carefully applied by the edge to the surface of the jacket. Two tests shall be performed on each specimen being moved forward 20 cm and rotated clockwise 90 degrees along the longitudinal axis between each test. Each test shall be discontinued when the specified number of cycles is attained for each of the two tests performed on each DUT. Measurement processes shall include 5a through 5c.

a. Perform the cable scraping abrasion test for the following specified number of cycles.

(1) Each cycle = 2 strokes.

(2) Thermoplastic cable jacket: 250 cycles (count = 500).

(3) Thermoset cable jacket: 750 cycles (count = 1,500).

b. Reposition and rotate cable and redo test.

(1) Ensure scraping abrasion test apparatus is off.

(2) Unclamp cable, and move it up 20.32 cm (8 inches) so that the 55.88 cm (22 inch) mark is centered directly above the top center of scraping drum, rotate cable 90 degrees in a clockwise direction and clamp.

(3) Use a ratchet style micrometer or other suitable measurement equipment to measure the diameter of the cable at the first set of marked rings and record. Since the diameter is being sought both before and after abrasion test, obtain the measurement so that one end of the micrometer is on the surface to be abraded.

(4) Set stroke counter on scraping abrasion test apparatus to zero.

(5) Place trash can under cable to catch cable scrapings. Ensure that the test weight is not in contact with sides of trash can.

(6) Redo the cable scraping abrasion test for the following specified number of cycles.

(a) Each cycle = 2 strokes.

(b) Thermoplastic cable jacket: 250 cycles (count = 500).

(c) Thermoset cable jacket: 750 cycles (count = 1,500).

(7) Ensure scraping abrasion test apparatus is off.

(8) Unclamp cable, measure each abraded surface at the marked areas and record.

(9) Repeat 4.7 through 4.10 and 5a to 5b(8) for each sample to be tested.

(10) Calculate the difference for each measurement and record.

MEASUREMENT 3203

c. Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet shall include the items listed in 5c(1) through 5c(4).

(1) Type of scraping surface (high speed tool bit).

(2) Type of test weight.

(3) Method used to affix test weight onto DUT.

(4) Table with each measurement obtained with units of measure, position on cable, and change (Δ) from pre-test diameter measurement.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3203

APPENDIX A

CABLE SCRAPING RESISTANCE SAMPLE DATA SHEET

DATA SHEET

CABLE SCRAPING ABRASION TEST (MSA)

DUT description: _____
Item code: _____
Tested by: _____
Test date: _____

Tube position (mm)	Tube O.D. pre-test (mm)	Tube O.D. post 250 cycles (mm)	Delta tube O.D. post 250 cycles (mm)	Tube O.D. post 750 cycles (mm)	Delta tube O.D. post 750 cycles (mm)	Pass/ fail

Comments:

1. Measurement 3202 is found in MIL-STD-1678-3.

2. Delta tube O.D. refers to current tube O.D. relative to pre-test O.D.

ENVIRONMENTAL MEASUREMENTS

3301 - 3308

MEASUREMENT 3301

TEMPERATURE-CYCLING.

1. Purpose. This measurement is performed when there is the requirement to subject the FOCT (fiber optic cable topology) component or device under test (DUT) to cyclic effect for stimuli of temperature. This test is intended to be used as part of qualification testing. The applicable commercial test standard cited is for temperature cycling (TIA-455-3) with imposing further refinements or boundaries (constraints). To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA-455-3	-	Procedures to Measure Temperature Cycling Effects on Optical Fiber Units, Optical Cable, and Other Passive Fiber Optic Components.
TIA-455-20	-	Measurement Methods and Test Procedures-Monitoring of Changes in Optical Transmittance (IEC-60793-1-46 Optical Fibers Part 1-46).

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Temperature cycling test. A test performed to determine the capability of an operational DUT when simulating temperature changes in the surrounding environment.

4. Test setup.

a. The change in optical transmittance shall be measured during and after the test.

b. Test fixture and other non DUT masses inside the chamber.

(1) Test fixture. If used, test fixture must be of minimum mass and approved by the Government technical authority.

(2) Non DUT masses. No other mass (item that causes significant thermal lag) shall be added inside the chamber.

5. Test procedure.

5.1 Test method. DUT (test samples) shall be tested in accordance with TIA-455-3 for test methodology using the number of cycles, test condition schedule, and ramp/soak times listed in the individual component military specification.

5.1.1 Modification of the temperature cycle. The temperature cycling limits may be modified for conformance with the operating temperature range. Unless otherwise specified, the temperature cycle profile for general applications shall be performed to table 3301-I.

TABLE 3301-1. General applications, temperature cycling steps.

Step	Temperature (°C)	Duration (hours)
1. Maintain	Room ambient	4 (min)
2. Ramp to	Low operating temp +0, -3	2
3. Maintain	Low operating temp +0, -3	2 (min)
4. Ramp to	25±2	2
5. Maintain	25±2	2 (min)
6. Ramp to	High operating temp +3, -0	1
7. Maintain	High operating temp +3, -0	2 (min)
8. Ramp to	25±2	1
9. Maintain	25±2	2 (min)
10. Repeat steps 2 through 9 four additional times (a total of 5 cycles).		

5.1.2 Aircraft applications. Unless otherwise specified, the temperature cycle profile for aircraft applications shall be performed to table 3303-II.

TABLE 3301-II Aircraft applications, temperature cycling steps.

Step	Cycle	Action	Temperature °C (°F)	Duration 1/
1	1	Maintain	25 +/-2 (77 +/-4)	4 hours (minimum)
2		Ramp to	-55 +0/-3 (-67 +0/-5)	7.5 minutes
3		Maintain	-55 +0/-3 (-67 +0/-5)	15 minutes (minimum)
4		Ramp to	165 +3/-0 (329 +5/-0)	22 minutes
5		Maintain	165 +3/-0 (329 +5/-0)	15 minutes (minimum)
6	2	Ramp to	-55 +0/-3 (-67 +0/-5)	22 minutes
7		Maintain	-55 +0/-3 (-67 +0/-5)	15 minutes (minimum)
8		Ramp to	165 +3/-0 (329 +5/-0)	22 minutes
9		Maintain	165 +3/-0 (329 +5/-0)	15 minutes (minimum)
10	3-10	Repeat steps 6 thru 9, 8 additional times, for a total of 10 cycles.		
11	Post 10	Ramp to	25 ±2 (77 ±4)	6 minutes
12		Maintain	25 ±2 (77 ±4)	4 hours (minimum)

1/ Ramp rate is 10°C per minute or faster, soak time (maintain step) is 15 minutes.

5.1.3 Verification. The checklist in appendix A is provided to ensure compliance for inspection purposes.

MEASUREMENT 3301

5.1.4 Exceptions. Exceptions to TIA-455-3.

5.1.4.1. Do not un-mate connectors. Mated DUTs are not to be un-mated and re-mated between environmental tests. The TIA requirement to mate and un-mate after test is part of inspection. Mated connectors were not un-mated to preserve continuity and reduce variables in testing.

5.1.4.2 Exceeding maximum ramp rate. The TIA maximum ramp rate is 40°C/hr. This ramp rate is exceeded when temperature cycle profile is to table 3303-II or as specified in the individual component military specification.

5.1.5 Test interruptions. If interruption exceeds 1 hour, then test must be continued as specified in accordance with 4.3.1.

5.2 Test synopsis.

a. Mount DUT assemblies in a test fixture, if specified.

b. Perform pre-test visual exam for any damage.

c. Perform setup and allow DUT assemblies to relax and test equipment to stabilize for 24 hours at 25°C.

d. Record pre-test optical transmittance of DUT assemblies at 25°C.

e. Perform test as follows unless otherwise specified in the component military specification:

(1) Use temperature cycle using minimum soak times in accordance with table A of TIA-455-3 and revise for total weight of DUT. (For instance, use a minimum of 4 hours for a maximum test sample weight, including exposed cable, of 3.3 pound or less.) Unless otherwise specified, use table 3303-I for general applications and table 3303-II for aircraft applications. Unless otherwise specified, no revision in the minimum soak time shall be made for measurements performed using table 3303-II.

(2) Precondition at 25°C for 24 hours.

(3) Perform 5 cycles consisting of the ramp and soak steps listed below. Soak at the specified duration, otherwise use the minimum soak times in accordance with table A of TIA-455-3 for total weight of DUT. If the duration of a ramp is not specified, then refer to 5.1.4.2.

(a) Ramp down to low operating temperature.

(b) Soak at low operating temperature. (minimum 2 hours in accordance with above for 3.3 pounds or less.)

(c) Ramp up to 25°C ±2°C.

(d) Soak at 25°C ±2°C.

(e) Ramp up to high operating temperature.

(f) Soak at high operating temperature.

(g) Ramp down to 25°C ±2°C.

(h) Soak at 25°C ±2°C .

(4) Unless otherwise specified, record optical transmittance during each cycle at end of the high temperature plateau and at the end of the low temperature plateau.

(5) Allow DUT assemblies to relax and test equipment to stabilize for 24 hours after the test at 25°C.

(6) Measure and record optical transmittance of DUT assemblies at 25°C.

(7) Perform post test visual exam (see 5.4).

5.3 Optical measurements.

5.3.1 Change in optical transmittance. The change in optical transmittance shall be measured during and after the test (from a baseline obtained before each test) in accordance with TIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in MIL-STD-1678-2 measurement 2102. At a minimum for the “during test” measurements, an optical transmittance measurement shall be performed towards the end of each high temperature and low temperature soak period (also referred to as the “maintain step”) or as specified in the individual component military specification.

5.3.2 Optical instrumentation capacity. This optical monitoring assumes that an optical measurement system is available with a sufficient channel measurement capability and that only one optical source exists that requires only one monitoring channel (to monitor and compensate for optical source drift).

5.4 Post test visual examination.

5.4.1 Connector. Dependent upon connector construction, DUT visual inspection may include no evidence of mechanical damage, loosening of component parts, separation of bonded surfaces, permanent set, cracking, crazing, stickiness, delaminating, degradation, distortion, separation, deterioration of identification marking, leaking or filling of potting compounds, no other damage detrimental to the operation of the connector.

5.4.2 Cable. DUT visual inspection of fiber may include no cracking or melting of the fiber coating material. DUT visual inspection of other cable components may include no evidence of permanent set, cracking, crazing, stickiness, delaminating, degradation, distortion.

5.4.3 Other. DUT visual inspection may include no leakage or other apparent loss of sealing capability, no surface or identification marking impairment, nor any damage detrimental to the operation of the test samples.

5.5 Contamination. When test samples are comprised of connectors or termini, the ferrule end face of each connector/termini mated pair shall be inspected for cleanliness after the completion of the test or during specified points during and after the completion of the test, as specified. Inspection shall be performed using a Fiber Optic Video Inspection System (FOVIS). As an option, each end face shall be captured using software provided with the FOVIS. For each cleaning operation performed, a table is requested to summarize the number of cleaning steps, cleaning device, cycle used, and result.

5.6 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2102, the data sheet is to list the items in 5.6.a through 5.6.d.

a. If DUT being tested are connectors, verify that testing is done with all connectors mated.

b. Specify chamber heating and cooling rates.

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c. Specify chamber temperature limits.

d. Specify placement of temperature sensor relative to DUT.

6. Notes.

6.1 Intended use, qualification testing. Stresses are applied to simulate conditions over a lengthy in-service duration and that under the stresses to show compliance with specification requirements.

6.2 Source for profiles.

6.2.1 General applications, for joint service applications. The specification requirements, along with the general temperature profile, were developed by a committee with representatives from different military services and from fiber optic component vendors.

6.2.2 Aircraft applications. The temperature cycling profile for aircraft applications were developed by representatives from the reliability, wiring, and standards and technology communities.

APPENDIX A

MINIMUM ESSENTIAL CHECKLIST FOR TEMPERATURE-CYCLING MEASUREMENTS

A.1 Purpose. This appendix addresses a checklist of the minimum essentials for the temperature-cycling measurement.

A.2 Usage. Table 3301A-I is the checklist of minimum essentials for Government auditors, or their representatives, to use during inspections. This checklist should be expanded at the auditor's discretion.

TABLE 3301A-I. Minimum essential checklist for temperature-cycling measurements.

Item	Category	Description	Requirement	Compliance
1	Test sample configuration	Cable assembly length: Connectors and splices Other fiber optic components: See MIL-STD-1678-4	10 meters minimum (13 m if to do 3 cut-backs) Complies with part 4 of this standard practice	
2	Room ambient environmental condition	Standard ambient (if test equipment built to operate in this range, if not-then controlled ambient)	23°C ±5°C/73°F ±9°F and 20% to 70% RH	
		Controlled ambient	23°C ±2°C/73°F ± 4°F and 45% to 55% RH	
3	Test condition	Test setup cable routing	Bend diameters ≥ min long term bend dia.	
			Sharp twists and bends avoided	
			Avoid protrusions/other obstacles	
4	Environmental Chamber charts	Temperature profile recorded	Chart, stored data on disk, other approved means	
			Includes chamber model and serial, date of test	
			Recording device accuracy is at least ±1°C over DUT operating temperature range	
	Test equipment			
5	Environmental chamber	Temperature rate of change	Meets minimum, both heating and cooling rates on profile	
		Temperature limits	Exceeds minimum and maximum DUT temperature limits on profile	
		Programmable to perform cycles show in table 3301-I, 3301-II or as specified	Chart/printout shows correct cycle with temperatures and times	
6	Optical measure-ments	Change in optical transmittance	Compliance with MIL-STD-1678-2 measurement 2101	

TABLE 3301A-I. Minimum essential checklist for temperature-cycling measurements - Continued.

Item	Category	Description	Requirement	Compliance
7	Examinations	Visual inspection	No leakage, loss of sealing capacity, damage detrimental to operation.	
		Ferrule end face contamination	FOVIS inspected and cleaned. Table provided summarizing cleaning steps, cleaning device, cycle used, and result.	
		Optical fiber connections	Routed outside chamber or to an optical interface port at chamber wall	
8	Test setup	Test fixture, if used	Minimize mass	
		Items to minimize variation in test	Approved by Government tech authority	
			No other mass inside chamber	
			Secure/tie down cables (no move at instr. ports)	
		Test processes	Compliance with measurement 3301	
9	Test	Maintain setup during test (source end)	No disconnection allowed until after testing completed (see MIL-STD-1678-2 measurement 2101, 2102 and 2104)	
		Temperature-cycle	Graph or electronic means to verify cycles in accordance with table 3301-I, 3301-II or component mil-spec is obtained	
		Alteration in temperature cycle limits, if altered	Same ramp rates occur	
			Same temperature soak times maintained	
		Electronically calculated	Verify proper equation in program	
10	Calculation	Operator performed calculations	Verify correct method used and calculated properly	
		Approved data sheet	Compliance with MIL-STD-1678-2 measurement 2201	
11	Data Sheet	Added data sheet requirement	Chamber heating and cooling rates	
			Chamber temperature limits	
			Temperature sensing device placement relative to DUT	
			If connector, was DUT mated or unmated	
		Proper criteria specified	Conforms with SPEC/contract parameters and values	
12	Pass/fail criteria	Proper criteria implemented	Test operators knows if fail and to verify result	

A.3 Notes.

A.3.1 Intended use.

A.3.1.1 Audit team. This checklist is intended to assist Government auditors or their representatives during inspections of the optical measurement system. This checklist may be augmented at the auditor's discretion; however, it is not to be reduced.

A.3.1.2 Test laboratories. When test laboratories prepare to perform temperature cycling measurements or audits, this checklist should be used to supplement measurement 3301, not replace it.

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TEMPERATURE-HUMIDITY CYCLING.

1. Purpose. This measurement is performed when there is the requirement to subject the FOCT (fiber optic cable topology) component or device under test (DUT) to humidity along with a cyclic effect for stimuli of temperature. This test is intended to be used as part of qualification testing. The applicable commercial test standard cited is for temperature-humidity cycling (TIA/EIA-455-5) with imposing further refinements or boundaries (constraints). To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA-455-20	-	Measurement Methods and Test Procedures-Monitoring of Changes in Optical Transmittance (IEC-60793-1-46 Optical Fibers Part 1-46).
TIA/EIA-455-5	-	Humidity Test Procedure for Fiber Optic Components.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Temperature-humidity cycling test. A test performed to determine the capability of an operational DUT when simulating humidity with a condition of cyclic temperature changes in the surrounding environment.

4. Test setup.

a. The change in optical transmittance shall be measured during and after the test.

b. Test fixture and other non DUT masses inside the chamber.

(1) Test fixture. If used, test fixture must be of minimum mass and approved by the Government technical authority.

(2) Non DUT masses. No other mass (item that causes significant thermal lag) shall be added inside the chamber.

5. Test procedure.

5.1 Test method. DUT (test samples) shall be tested in accordance with TIA/EIA-455-5 for humidity using the temperature-humidity profile in accordance with method B of TIA/EIA-455-5 with the sub-cycle of 7a performed as part of the cycle (with preference for cycles 1, 3, 5, 7, and 9 for standardization).

5.1.1 Modification of the cycle. None permitted.

5.1.2 Aircraft applications. Unless otherwise specified, same test shall be performed.

5.1.3 Verification. The checklist in appendix A is provided to ensure compliance for inspection purposes.

5.1.4 Exceptions. Exceptions to TIA/EIA-455-5.

5.1.4.1 Do not un-mate connectors. Mated DUTs are not to be un-mated and re-mated between environmental tests. The TIA requirement to mate and un-mate after test is part of inspection. Mated connectors were not un-mated to preserve continuity and reduce variables in testing.

5.1.4.2 Stabilization time after test completion. TIA requirement is to allow DUT assemblies to stabilize for 2 hours after the test at 25°C, then measure optical transmittance. Instead, allow the DUT to relax/stabilize for 24 hours to provide sufficient “relaxation” time after an environmental test.

5.1.5 Chamber used.

5.1.5.1 One chamber used. The entire test shall be performed in the same chamber. No movement between chambers for various parts of the cycle is allowed.

5.1.5.2 DUT placement in chamber. DUT shall be placed in the chamber so that no dripping or condensation or restriction of air flow on the DUT occurs.

5.1.5.3 Vent cap in chamber. Chamber shall contain a vent cap to allow escape of any pressure buildup.

5.1.5.4 Wet bulb and dry bulb measurement. If humidity control is sensed by wet bulb and dry bulb thermometers, cleaning of the reservoir and periodic replacement of the wick shall be performed as specified (every 30 days minimum). Minimum air flow across the wet bulb sensor shall be 275 m/min (900 ft/min).

5.1.5.5 Air flow within chamber. Air shall be circulated through the chamber interior at a sufficient rate, but shall not exceed a velocity of 46 m/min (150 ft/min).

5.1.6 Test interruptions. If interruption exceeds 1 hour, then test must be continued as specified in accordance with 4.3.1.

5.2 Test synopsis.

a. Perform pre-test visual exam for any damage.

b. Mount DUT assemblies in a test fixture, if specified.

c. Place each DUT in chamber so that there is no air flow restriction, does not contact other DUT, and is exposed to same percent RH.

d. Perform setup and allow DUT assemblies to relax and test equipment to stabilize for 24 hours at 25°C.

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e. Record pre-test optical transmittance of DUT assemblies at 25°C.

f. Perform test using the temperature-humidity profile in accordance with method B of TIA/EIA-455-5 with the sub-cycle of 7a performed as part of the cycle (with preference for cycles 1, 3, 5, 7, and 9 for standardization).

(1) Perform test for ten cycles. Include the optional sub-cycle in the test. Test temperature range: -10°C to 65°C.

(a) Five 24 hour cycles with temperature range: -10 to 65 ^{o}C.

(b) Five 24 hour cycles with temperature range: 25 to 65 ^{o}C.

(c) Humidity held at 90 percent or 95 percent RH during first 16 hours of each cycle and is uncontrolled (off) if the cycle includes the step 7a sub-cycle. Otherwise, the humidity is held at 90 percent or 95 percent RH.

(2) Record optical transmittance during each cycle at end of one high temperature plateau and at the ambient temperature or low temperature (optional sub-cycle) plateau.

(3) Total test duration shall not be less than 240 hours.

(4) Allow DUT assemblies to relax and test equipment to stabilize for 24 hours after the test at 25°C.

(5) Measure and record optical transmittance of DUT assemblies at 25°C.

(6) Perform post test visual exam (see 5.4).

5.3 Optical measurements.

5.3.1 Change in optical transmittance. The change in optical transmittance shall be measured during and after the test (from a baseline obtained before each test) in accordance with TIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in MIL-STD-1678-2 Measurement 2102. At a minimum for the “during test” measurements, an optical transmittance measurement shall be performed during each cycle at end of one high temperature plateau and at the ambient temperature or low temperature (optional sub-cycle) plateau or as specified in the individual component military specification.

5.3.2 Optical instrumentation capacity. This optical monitoring assumes that an optical measurement system is available with a sufficient channel measurement capability and that only one optical source exists that requires only one monitoring channel (to monitor and compensate for optical source drift).

5.4 Post test visual examination.

5.4.1 Connector. Dependent upon connector construction, DUT visual inspection may include no evidence of mechanical damage, loosening of component parts, separation of bonded surfaces, permanent set, cracking, crazing, stickiness, delaminating, degradation, distortion, separation, deterioration of identification marking, leaking or filling of potting compounds, nor other damage detrimental to the operation of the connector.

5.4.2 Cable. DUT visual inspection of fiber may include no cracking or melting of the fiber coating material. DUT visual inspection of other cable components may include no evidence of permanent set, cracking, crazing, stickiness, delaminating, degradation, nor distortion.

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5.4.3 Other. DUT visual inspection may include no leakage or other apparent loss of sealing capability, no surface or identification marking impairment, nor any damage detrimental to the operation of the test samples.

5.5 Contamination. When test samples are comprised of connectors or termini, the ferrule end face of each connector/termini mated pair shall be inspected for cleanliness after the completion of the test or during specified points during and after the completion of the test, as specified. Inspection shall be performed using a Fiber Optic Video Inspection System (FOVIS). As an option, each end face shall be captured using software provided with the FOVIS. For each cleaning operation performed, a table is requested to summarize the number of cleaning steps, cleaning device, cycle used, and result.

5.6 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet is to list the items in 5.6a through 5.6e.

a. Verification of mated conditions. If DUT being tested are connectors, verify that testing is done with all connectors mated.

b. Specify chamber heating and cooling rates.

c. Specify chamber temperature and humidity limits.

d. Specify placement of temperature sensor relative to DUT.

e. Specify type of humidity sensor.

6. Notes.

6.1 Intended use, qualification testing. Stresses are applied to simulate conditions over a lengthy in-service duration and that under the stresses to show compliance with specification requirements.

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APPENDIX A

MINIMUM ESSENTIAL CHECKLIST FOR TEMPERATURE HUMIDITY CYCLING MEASUREMENTS

A.1 Purpose. This appendix addresses a checklist of the minimum essentials for the temperature-humidity cycling measurement.

A.2 Usage. Table 3302A-I is the checklist of minimum essentials for Government auditors, or their representatives, use during inspections. This checklist should be expanded at the auditor's discretion.

TABLE 3302A-I. Minimum essential checklist for temperature-humidity cycling measurements.

Item	Category	Description	Requirement	Compliance
1	Test sample configuration	Cable assembly length: Connectors and splices Other fiber optic components: See MIL-STD-1678-4	10 meters minimum (13 m if to do 3 cut-backs) Complies with Part 4 of this standard practice	
2	Room ambient environment-al condition	Standard ambient (if test equipment built to operate in this range, if not-then controlled ambient)	23°C ± 5°C/73°F ± 9°F and 20% to 70% RH	
		Controlled ambient	23°C ± 2°C/73°F ± 4°F and 45% to 55% RH	
3	Test condition	Test setup cable routing	Bend diameters ≥ min long term bend dia	
			Sharp twists and bends avoided	
			Avoid protrusions/other obstacles	
4	Environmental chamber charts	Temperature and humidity profiles recorded	Chart, stored data on disk, other approved means	
			Includes chamber model and serial, date of test	
			Recording device accuracy is at least ±1°C over test temperature range	
			Recording device accuracy is at least ±3% RH over test range	
	Test equipment			
5	Environmental chamber	Temperature rate of change	Meets minimum, both heating and cooling rates on profile	
		Temperature limits	Exceeds minimum and maximum DUT temperature limits on profile	
		Humidity limits	Exceeds minimum and maximum DUT humidity limits on profile	
		Programmable to perform cycles show TIA/EIA-455-5, method B profile	Chart/printout shows correct cycle with temperatures, humidity and times	
		One chamber used	The entire test performed in the same chamber	

TABLE 3302A-I. Minimum essential checklist for temperature-humidity cycling measurements - Continued.

Item	Category	Description	Requirement	Compliance
5	Environmental chamber continued	DUT placement in chamber	DUT placed in the chamber so no dripping/condensation or restriction of air flow occurs	
		Vent cap in chamber	Chamber contain a means to vent any pressure buildup	
		If measure with wet bulb and dry bulb sensors/thermometers	Cleaning of reservoir and periodic replacement of the wick performed (every 30 days minimum). Minimum air flow across the wet bulb sensor is 275 m/min (900 ft/min)	
		Air flow within chamber	Air circulated through the chamber interior does not exceed 46 m/min (150 ft/min)	
6	Optical measure-ments	Change in optical transmittance	Compliance with MIL-STD-1678-2 measurement 2101	
7	Examinations	Visual inspection	No leakage, loss of sealing capacity, damage detrimental to operation.	
		Ferrule end face contamination	FOVIS inspected and cleaned. Table provided summarizing cleaning steps, cleaning device, cycle used, and result.	
		Optical fiber connections	Routed outside chamber or to an optical interface port at chamber wall	
9	Test setup	Test fixture, if used	Minimize mass	
		Items to minimize variation in test	Approved by Government tech authority	
			No other mass inside chamber	
			Secure/tie down cables (no move at instr. ports)	
		Test processes	Compliance with measurement 3302	
10	Test	Maintain setup during test (source end)	No disconnection allowed until after testing completed (see MIL-STD-1678-2, measurement 2101, 2102 and 2104)	
		Temperature-humidity cycle	Graph or electronic means to verify cycles in accordance with method B profile	
		Electronically calculated	Verify proper equation in program	
11	Calculation	Operator performed calculations	Verify correct method used and calculated properly	
		Approved data sheet	Compliance with MIL-STD-1678-2 measurement 2201	

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TABLE 3302A-I. Minimum essential checklist for temperature-humidity cycling measurements - Continued.

Item	Category	Description	Requirement	Compliance
12	Data sheet	Added data sheet requirement	Chamber heating and cooling rates	
			Chamber temperature limits	
			Temperature sensing device placement relative to DUT	
			If connector, was DUT mated or unmated	
			Chamber humidity limits	
			Type of humidity sensor	
		Proper criteria specified	Conforms with SPEC/contract parameters and values	
13	Pass/fail criteria	Proper criteria implemented	Test operators knows if fail and to verify result	

A.3 Notes.

A.3.1 Intended use.

A.3.1.1 Audit team. This checklist is intended to assist Government auditors or their representatives during inspections of the optical measurement system. This checklist may be augmented at the auditor's discretion; however, it is not to be reduced.

A.3.1.2 Test laboratories. When test laboratories prepare to perform temperature humidity cycling measurements or audits, this checklist should be used to supplement measurement 3302, not replace it.

MEASUREMENT 3303

TEMPERATURE LIFE (LIFE AGING).

1. Purpose. This measurement is performed when there is the requirement to subject the FOCT (fiber optic cable topology) component or device under test (DUT) to an elevated temperature effect with a specified duration for stimuli of temperature. This test is intended to be used as part of qualification testing. The applicable commercial test standard cited is for temperature life (TIA/EIA-455-4) with imposing further refinements or boundaries (constraints). To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a standardized approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA-455-20	-	Measurement Methods and Test Procedures-Monitoring of Changes in Optical Transmittance (IEC-60793-1-46 Optical Fibers Part 1-46).
TIA/EIA-455-4	-	Fiber Optic Component Temperature Life Test.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Temperature life test. A test performed to determine the capability of an operational DUT when stimulated at an elevated temperature for a specified duration. This test is usually performed at or below the maximum temperature found in service and for a prolonged duration.

3.2 Life aging test. A test performed to determine the capability of an operational DUT when the stimulus is applied at an elevated level beyond that found in operation (or beyond the DUT rating) with an accompanied reduction in the test duration. For a temperature stimulus, this test is usually performed above the maximum temperature found in service. The test temperature may be referred to as the accelerated aging temperature. The higher the accelerated aging temperature, the further the reduction in the test duration.

3.3 Life aging (temperature life). This terminology may be used when the test is performed for different environmental conditions, where at least one test is an accelerated aging test and at least one is done at the maximum service temperature limit for a prolong duration, or for a test where either the accelerated aging temperature or maximum service temperature is specified.

4. Test setup.

a. The change in optical transmittance shall be measured after the test. For engineering analysis purposes, Optical transmittance measurements may be obtained during the test for engineering informational purposes (and is encouraged), but shall not be considered in determining if the DUT met the pass/fail criteria.

b. Test fixture and other non DUT masses inside the chamber.

(1) Test fixture. If used, test fixture must be of minimum mass and approved by the Government technical authority.

(2) Non DUT masses. No other mass (item that causes significant thermal lag) shall be added inside the chamber.

5. Test procedure.

5.1 Test method. DUT (test samples) shall be tested in accordance with TIA/EIA-455-4 for test methodology using the test temperature and test duration listed in the individual component military specification.

5.1.1 Modification of the test temperature. When an accelerated aging test is performed and the material conditions of the DUT cannot withstand the accelerated aging temperature, the temperature may be reduced if approved by the qualifying activity. As a rule of thumb, the duration of the test may be increased by a factor of 2 for every 10 ^{0}C decrease in temperature. For purposes of testing consistency and potential introduction of other variables, the test temperature shall not be increased to allow for a reduction in test duration.

5.1.2 Aircraft applications. Unless otherwise specified, DUT shall be tested in accordance with TIA/EIA-455-4 for the duration of 1,000 hours at the high exposure temperature of 165°C +5°C, -0°C.

5.1.3 Verification. The checklist in appendix A is provided to ensure compliance for inspection purposes.

5.1.4 Exceptions. Exceptions to TIA/EIA-455-4.

5.1.4.1 Do not un-mate connectors. Mated DUTs are not to be un-mated and re-mated between environmental tests. The TIA requirement to mate and un-mate after test as part of inspection. Mated connectors were not un-mated to preserve continuity and reduce variables in testing.

5.1.4.2 Stabilization time after test completion. TIA requirement is to allow DUT assemblies to stabilize for 2 hours after the test at 25°C, then measure optical transmittance. Instead, allow the DUT to relax/stabilize for 24 hours to provide sufficient relaxation time after an environmental test.

5.1.4.3 Cable retention. TIA requirement to perform cable retention test as part of final inspection for this test. A separate cable retention test shall not be required.

5.1.5 Chamber used.

5.1.5.1 One chamber used. The entire test shall be performed in the same chamber.

5.1.5.2 DUT placement in chamber. DUT shall be placed in the chamber so that no restriction of air flow on the DUT occurs.

5.1.5.3 Air flow within chamber. If air is circulated through the chamber interior, the flow rate shall not exceed a velocity of 46 m/min (150 ft/min).

5.1.6 Test interruptions. If interruption exceeds 1 hour, then test must be continued as specified in accordance with 4.3.1.

5.2 Test synopsis.

a. Perform pre-test visual exam for any damage.

b. Mount DUT assemblies in a test fixture, if specified.

c. Place each DUT in chamber so that: No air flow restriction, does not contact another DUT.

d. Perform setup and allow DUT assemblies to relax and test equipment to stabilize for 24 hours at 25°C.

e. Record pre-test optical transmittance of DUT assemblies at 25°C.

f. Perform test in accordance with TIA/EIA-455-4 for test methodology using the test temperature and soak time listed in the individual component military specification.

(1) Ramp up to the specified accelerated aging temperature or maximum service temperature. It is recommended that this ramp be performed in not less than 2 hours.

(2) Soak at accelerated aging or maximum service temperature for the specified soak duration.

(3) Optional (for engineering information only): Record optical transmittance periodically (such as daily).

(4) Ramp down to 25±2°C after the total test duration or temperature soak is completed. It is recommended that this ramp be performed in not less than 2 hours.

(5) Allow DUT assemblies to relax and test equipment to stabilize for 24 hours after the test at 25°C.

(6) Measure and record optical transmittance of DUT assemblies at 25°C.

(7) Perform post test visual exam (see 5.4).

5.3 Optical measurements.

5.3.1 Change in optical transmittance. The change in optical transmittance shall be measured after the test (from a baseline obtained before each test) in accordance with TIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in MIL-STD-1678-2 measurement 2102.

5.3.2 Optical instrumentation capacity. This optical monitoring assumes that an optical measurement system is available with a sufficient channel measurement capability and that only one optical source exists that requires only one monitoring channel (to monitor and compensate for optical source drift).

5.4 Post test visual examination.

5.4.1 Connector. Dependent upon connector construction, DUT visual inspection may include no evidence of mechanical damage, loosening of component parts, separation of bonded surfaces, permanent set, cracking, crazing, stickiness, delaminating, degradation, distortion, separation, deterioration of identification marking, leaking or filling of potting compounds, no other damage detrimental to the operation of the connector.

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5.4.2 Cable. DUT visual inspection of fiber may include no cracking or melting of the fiber coating material. DUT visual inspection of other cable components may include no evidence of permanent set, cracking, crazing, stickiness, delaminating, degradation, nor distortion.

5.4.3 Other. DUT visual inspection may include no leakage or other apparent loss of sealing capability, no surface or identification marking impairment, nor any damage detrimental to the operation of the test samples.

5.5 Contamination. When test samples are comprised of connectors or termini, the ferrule end face of each connector/termini mated pair shall be inspected for cleanliness after the completion of the test or during specified points during and after the completion of the test, as specified. Inspection shall be performed using a Fiber Optic Video Inspection System (FOVIS). As an option, each end face shall be captured using software provided with the FOVIS. For each cleaning operation performed, a table is requested to summarize the number of cleaning steps, cleaning device, cycle used, and result.

5.6 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet is to list the items in 5.6a through 5.6f.

a. Verification of mated conditions. If DUT being tested are connectors, verify that testing is done with all connectors mated.

b. Specify chamber heating rate.

c. Specify chamber high temperature limit.

d. Specify placement of temperature sensor relative to DUT.

e. Specify test accelerated aging temperature or maximum service temperature.

f. Specify test soak duration.

6. Notes.

6.1 Intended use, qualification testing. Stresses are applied to simulate conditions over a lengthy in-service duration and that under the stresses to show compliance with specification requirements.

APPENDIX A

MINIMUM ESSENTIAL CHECKLIST FOR TEMPERATURE LIFE MEASUREMENTS

A.1. Purpose. This appendix addresses a checklist of the minimum essentials for the temperature life measurement.

A.2. Usage. Table 3303A-I is the checklist of minimum essentials for Government auditors, or their representatives, used during inspections. This checklist should be expanded at the auditor's discretion.

TABLE 3303A-I. Minimum essential checklist for temperature life measurements.

Item	Category	Description	Requirement	Compliance
1	Test sample configuration	Cable assembly length: Connectors and splices	10 meters minimum (13 m if to do 3 cut-backs)	
		Other fiber optic components: See MIL-STD-1678-4	Complies with Part 4 of this standard practice	
2	Room ambient environmental condition	Standard ambient (if test equipment built to operate in this range, if not-then controlled ambient)	23°C ±5°C/73°F ±9°CF and 20% to 70% RH	
		Controlled ambient	23°C ±2°C/73°F ± 4°F and 45% to 55% RH	
3	Test condition	Test setup cable routing	Bend diameters ≥ min long term bend dia	
			Sharp twists and bends avoided	
			Avoid protrusions/other obstacles	
4	Environmental chamber charts	Temperature soak recorded	Chart, stored data on disk, other approved means	
			Includes chamber model and serial, date of test	
			Recording device accuracy is at least ±1°C over test temperature range	
5	Test equipment			
		Temperature limit	Exceeds maximum DUT temperature limit	
		Programmable to perform soak in accordance with TIA/EIA-455-4 for specified duration	Chart/printout shows correct temperature and duration	
		One chamber used	The entire test performed in the same chamber	
		DUT placement in chamber	DUT placed in the chamber so no restriction of air flow occurs	
		Vent cap in chamber	Chamber contain a means to vent any pressure buildup	
		Air flow within chamber	If air circulated through the chamber interior, flow does not exceed 46 m/min (150 ft/min)	

TABLE 3303A-I. Minimum essential checklist for temperature life measurements - Continued.

Item	Category	Description	Requirement	Compliance
6	Optical measurements	Change in optical transmittance	Compliance with MIL-STD-1678-2 measurement 2101	
7	Examinations	Visual inspection	No leakage, loss of sealing capacity, or damage detrimental to operation.	
		Ferrule end face contamination	FOVIS inspected and cleaned. Table provided summarizing cleaning steps, cleaning device, cycle used, and result.	
		Optical fiber connections	Routed outside chamber or to an optical interface port at chamber wall	
9	Test setup	Test fixture, if used	Minimize mass	
		Items to minimize variation in test	Approved by Government tech authority	
			No other mass inside chamber	
			Secure/tie down cables (no move at instr. ports)	
		Test processes	Compliance with measurement 3303	
10	Test	Maintain setup during test (source end)	No disconnection allowed until after testing completed (see MIL-STD-1678-2 measurements 2101, 2102 and 2104)	
		Temperature tested and duration performed	Graph or electronic means to verify temperature maintained for specified duration	
		Electronically calculated	Verify proper equation in program	
11	Calculation	Operator performed calculations	Verify correct method used and calculated properly	
		Approved data sheet	Compliance with MIL-STD-1678-2 Measurement 2201	
12	Data Sheet	Added data sheet requirement	Chamber heating rate	
			Chamber temperature limit	
			Temperature sensing device placement relative to DUT	
			If connector, was DUT mated or unmated	
			Accelerated aging temperature or maximum service temperature at which test performed	
			Duration of soak at test temperature	
		Proper criteria specified	Conforms with spec/contract parameters and values	
13	Pass/fail criteria	Proper criteria implemented	Test operators knows if fail and to verify result	

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APPENDIX A

A.3 Notes.

A.3.1 Intended use.

A.3.1.1 Audit team. This checklist is intended to assist Government auditors or their representatives during inspections of the optical measurement system. This checklist may be augmented at the auditor's discretion; however, it is not to be reduced.

A.3.1.2 Test laboratories. When test laboratories prepare to perform temperature life measurements or audits, this checklist should be used to supplement measurement 3303, not replace it.

MEASUREMENT 3304

THERMAL SHOCK

1. Purpose. This measurement is performed when there is the requirement to subject the FOCT (fiber optic cable topology) component or device under test (DUT) to sudden changes in the stimuli of temperature that can occur in service during use, in shipment or in storage. This test is intended to be used as part of qualification testing. The applicable commercial test standard cited is for thermal shock (TIA-455-71) with imposing further refinements or boundaries (constraints). To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA-455-20	-	Measurement Methods and Test Procedures-Monitoring of Changes in Optical Transmittance (IEC-60793-1-46 Optical Fibers Part 1-46).
TIA-455-71	-	Procedure to Measure Temperature - Shock Effects on Fiber Optic Components.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Thermal shock. A test performed to determine the capability of an operational DUT when simulating sudden or rapid temperature changes in the surrounding environment that can occur in service during use, in shipment or in storage. The temperature ramps in each cycle performed are intended to be shock ramps as opposed to more gradual ramps found in a temperature cycling test.

4. Test setup.

a. The change in optical transmittance shall be measured after the test for general applications and measured during and after the test for aircraft applications.

b. Test fixture and other non-DUT masses inside the chamber.

(1) Test fixture. If used, test fixture must be of minimum mass and approved by the Government technical authority.

(2) Non-DUT masses. No other mass (item that causes significant thermal lag) shall be added inside the chamber.

(3) Transfer pans. When two chambers are used, the recommendation is made to place the DUT in pan to facilitate chamber transfer (connecting fixture may be used instead, if suitable for the transferring process). If metallic, line the transferring pan with low thermally conductive material at points that come into contact with DUT.

5. Test procedure.

5.1 Test method. DUT (test samples) shall be tested in accordance with TIA-455-71 for test methodology using the number of cycles, test condition schedule, and ramp/soak times either as specified in table 1 of TIA-455-71 for the test condition schedule or as listed in the individual component military specification.

5.1.1 Modification of the temperature limits. The temperature limits may be modified for conformance with the storage, non operating temperature or operating temperature range, as applicable. Unless otherwise specified, the temperature ramp/soak times/test condition schedule shall be as specified in the individual component military specification.

5.1.2 Aircraft applications. Unless otherwise specified, DUT shall be tested in accordance with TIA-455-71, schedule C-0 (5 cycles). The temperatures of -55°C +0°C/-5°C and 165°C +5°C/-0°C shall be used for the low and high soak temperatures, respectively. The change in optical transmittance shall be measured during (towards the end of each soak temperature) and after the test.

5.1.3 Verification. The checklist in appendix A is provided to ensure compliance for inspection purposes.

5.1.4 Exceptions. Exceptions to TIA-455-71.

5.1.4.1 Do not un-mate connectors. Mated DUTs are not to be un-mated and re-mated between environmental tests. The TIA requirement to mate and un-mate after test as part of inspection. Mated connectors were not un-mated to preserve continuity and reduce variables in testing.

5.1.4.2 Recording times for optical transmittance. See 5.1.2 and 5.3.1.2 for additional measurements required in aircraft applications.

5.1.5 Test interruptions. If interruption exceeds 1 hour, then test must be continued as specified in accordance with 4.3.1.

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5.1.6 Number of chambers used.

5.1.6.1 If one chamber used. The entire test may be performed in the same chamber only if the 5 minute ramp rates (both from high-to-low temperature limits and from low-to-high temperature limits) can be achieved.

5.1.6.2 If two chambers are used. The entire test may be performed in two chambers only if transport of DUT with attached cabling can be achieved in under 5 minutes and only if the chamber can recover to the specify temperature limit within 10 percent of the temperature soak (exposure) time. Chamber shall be configured so that ports or cable notches allow transfer of DUT with attached cabling well within the 5 minute allowed limit. For a two chamber transfer, chambers with cable notches are recommended.

5.1.7 Chamber considerations.

5.1.7.1 DUT placement in chamber. DUT shall be placed in the chamber so that no restriction of air flow on the DUT occurs.

5.1.7.2 Air flow within chamber. Air shall be circulated through the chamber interior, the flow rate shall not exceed a velocity of 46 m/min (150 ft/min).

5.2 Test synopsis.

a. Mount DUT assemblies in a test fixture, if one is used.

b. Perform pre-test visual exam for any damage.

c. Perform setup and allow DUT assemblies to relax and test equipment to stabilize for 24 hours at 25°C.

d. Record pre-test optical transmittance of DUT assemblies at 25°C.

e. Unless otherwise specified in the component military specification, perform test as follows: DUT shall be tested in accordance with TIA-455-71, schedule C-0 (5 cycles). Perform 5 cycle thermal shock test as specified in 5.2e(1) through 5.2e(9), when two chambers are used to perform the test.

(1) Test high and low temperature limits. The temperatures are specified either in the test condition schedule or listed in the individual component military specification.

(2) Soak times. Use minimum soak times in accordance with table 2 of TIA-455-71 and revise for total weight of DUT. Unless otherwise specified, no revision in the minimum soak time shall be made.

NOTE: Soak time is dependent upon total weight of DUTs and test fixtures (including transfer pan).

Test sample mass (lb) in accordance with TIA	Soak time (hr)
$M < 0.7$	0.5
$0.7 < M \leq 1.5$	1.0
$1.5 < M \leq 3.3$	2.0
$3.3 < M \leq 33$	4.0
$33 < M \leq 220$	8.0

(3) Soak DUT assemblies at low temperature limit (see 5.2e(1)) for specified soak duration (see 5.2e(2)). For aircraft applications, record optical transmittance during final 5 minutes of soak.

(4) Transfer DUT assemblies to chamber stabilized at the high temperature limit within a 5 minute transition time.

(5) Soak DUT assemblies at high temperature limit (see 5.2e(1)) for specified soak duration (see 5.2e(2)). For aircraft applications, record optical transmittance during final 5 minutes of soak.

(6) Repeat steps 5.2e(3) and 5.2e(4) for 4 additional cycles (or the number of cycles specified).

(7) Allow DUT assemblies to relax and test equipment to stabilize for 24 hours after the test at 25°C.

(8) Measure and record optical transmittance of DUT assemblies at 25°C.

(9) Perform post test visual exam (see 5.4).

5.3 Optical measurements.

5.3.1 Change in optical transmittance.

5.3.1.1 General applications. The change in optical transmittance shall be measured during after the test (from a baseline obtained before each test) in accordance with TIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in MIL-STD-1678-2 measurement 2102.

5.3.1.2 Aircraft applications. The change in optical transmittance shall be measured during and after the test (from a baseline obtained before each test) in accordance with TIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in MIL-STD-1678-2 measurement 2102. At a minimum for the “during test” measurements, an optical transmittance measurement shall be performed towards the end of each high temperature and low temperature soak period (also referred to as the “maintain step”) or as specified in the individual component military specification. The rapid excursions of temperature that occur during the operation of aircraft mandate simulating this in-service condition during testing by obtaining optical transmittance measurements during the test.

5.3.2 Optical instrumentation capacity. This optical monitoring assumes that an optical measurement system is available with a sufficient channel measurement capability and that only one optical source exists that requires only one monitoring channel (to monitor and compensate for optical source drift).

5.4 Post test visual examination.

5.4.1 Connector. Dependent upon connector construction, DUT visual inspection may include no evidence of mechanical damage, loosening of component parts, separation of bonded surfaces, permanent set, cracking, crazing, stickiness, delaminating, degradation, distortion, separation, deterioration of identification marking, leaking or filling of potting compounds, nor other damage detrimental to the operation of the connector.

5.4.2 Cable. DUT visual inspection of fiber may include no cracking or melting of the fiber coating material. DUT visual inspection of other cable components may include no evidence of permanent set, cracking, crazing, stickiness, delaminating, degradation, nor distortion.

5.4.3 Other. DUT visual inspection may include no leakage or other apparent loss of sealing capability, no surface or identification marking impairment, nor any damage detrimental to the operation of the test samples.

5.5 Contamination. When test samples are comprised of connectors or termini, the ferrule end face of each connector/termini mated pair shall be inspected for cleanliness after the completion of the test or during specified points during and after the completion of the test, as specified. Inspection shall be performed using a Fiber Optic Video Inspection System (FOVIS). As an option, each end face shall be captured using software provided with the FOVIS. For each cleaning operation performed, a table is requested to summarize the number of cleaning steps, cleaning device, cycle used, and result.

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5.6 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 measurement 2201, the data sheet is to list the items in 5.6a through 5.6g.

a. Verification of mated conditions. If DUT being tested are connectors, verify that testing is done with all connectors mated.

b. Specify chamber heating and cooling rates.

c. Specify chamber temperature limits.

d. Specify placement of temperature sensor relative to DUT.

e. Specify high and low test temperature limits.

f. Specify combined weight of DUT, portion of DUT cabling inside the chamber and any fixture or transfer pan used.

g. Specify test soak duration used based on the combined weight.

6. Notes.

6.1 Intended use, qualification testing. Stresses are applied to show compliance with specification requirements.

APPENDIX A

MINIMUM ESSENTIAL CHECKLIST FOR THERMAL SHOCK MEASUREMENTS

A.1 Purpose. This appendix addresses a checklist of the minimum essentials for the thermal shock measurement.

A.2 Usage. Table 3304A-I is the checklist of minimum essentials for Government auditors, or their representatives, to use during inspections. This checklist should be expanded at the auditor's discretion.

TABLE 3304A-I. Minimum essential checklist for thermal shock measurements.

Item	Category	Description	Requirement	Compliance
1	Test sample configuration	Cable assembly length: Connectors and splices Other fiber optic components: See MIL-STD-1678-4	10 meters minimum (13 m to do 3 cut-backs) Complies with part 4 of this standard practice	
2	Room ambient environmental condition	Standard ambient (if test equipment built to operate in this range, if not-then controlled ambient)	23°C ±5°C/73°F ±9°F and 20% to 70% RH	
		Controlled ambient	23°C ±2°C/73°F ±4°F and 45% to 55% RH	
3	Test condition	Test setup cable routing	Bend diameters ≥ min long term bend diameter	
			Sharp twists and bends avoided	
			Avoid protrusions/other obstacles	
4	Environmental chamber charts	Temperature profile recorded	Chart, stored data on disk, other approved means	
			Includes chamber model and serial, date of test	
			Recording device accuracy is at least ±2°C over DUT operating temperature range	
	Test equipment			
5	Environmental chamber	Temperature rate of change	Meets minimum, both heating and cooling rates on profile	
		Temperature limits	Exceeds minimum and maximum test high and low temperature limits	
		Programmable or controlled to maintain temperatures or as specified	Chart/printout shows correct cycle/potion of cycle with temperatures and times	
6	Optical measurements	Change in optical transmittance	Compliance with MIL-STD-1678-2 measurement 2101	

TABLE 3304A-I. Minimum essential checklist for thermal shock measurements - Continued.

Item	Category	Description	Requirement	Compliance
7	Examinations	Visual inspection	No leakage, loss of sealing capacity, damage detrimental to operation	
		Ferrule end face contamination	FOVIS inspected and cleaned. Table provided summarizing cleaning steps, cleaning device, cycle used, and result.	
		Optical fiber connections	Routed outside chamber or to an optical interface port at chamber wall	
9	Test setup	Test fixture, if used	Minimize mass	
		Items to minimize variation in test	Approved by Government tech authority	
			No other mass inside chamber	
			Secure/tie down cables (no move at instr. ports)	
		Test processes	Compliance with measurement 3304	
10	Test	Maintain setup during test (source end)	No disconnection allowed until after testing completed (see MIL-STD-1678-2 measurements 2101, 2102, and 2104)	
		Temperature-cycle	Graph or electronic means to verify cycles in accordance with TIA-455-71 or component mil-spec is obtained	
		Alteration in temperature cycle limits, if altered	5 minute transfer rate occurred. Chamber recovered within 10 minutes of soak duration	
			Same temperature soak times maintained	
		Electronically calculated	Verify proper equation in program	
11	Calculation	Operator performed calculations	Verify correct method used and calculated properly	
		Approved data sheet	Compliance with MIL-STD-1678-2 measurement 2201	

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TABLE 3304A-I. Minimum essential checklist for thermal shock measurements - Continued.

Item	Category	Description	Requirement	Compliance
12	Data sheet	Added data sheet requirement	Chamber heating and cooling rates	
			Chamber temperature limits	
			Temperature sensing device placement relative to DUT	
			If connector, was DUT mated or unmated	
			High and low test temperature limits	
			Combined weight of DUT, portion of DUT cabling inside the chamber and any fixture or transfer pan used	
			Test soak duration used based on the combined weight	
		Proper criteria specified	Conforms with spec/contract parameters and values	
13	Pass/fail criteria	Proper criteria implemented	Test operators knows if fail and to verify result	

A.3 Notes.

A.3.1 Intended use.

A.3.1.1 Audit team. This checklist is intended to assist Government auditors or their representatives during inspections of the optical measurement system. This checklist may be augmented at the auditor's discretion; however, it is not to be reduced.

A.3.1.2 Test laboratories. When test laboratories prepare to perform thermal shock measurements or audits, this checklist should be used to supplement measurement 3304, not replace it.

MEASUREMENT 3305

ALTITUDE IMMERSION

1. Purpose. This measurement is performed when there is the requirement to subject the FOCT (fiber optic cable topology) component or device under test (DUT) to sudden or rapid descents from high to low altitudes with the accompanied condensation of moisture. Multiple rapid descents are simulated with a cyclic effect for the stimulus of altitude. This test is intended to be used as part of qualification testing. The applicable commercial test standard cited is for altitude immersion (TIA-455-15) with imposing further refinements or boundaries (constraints). To ensure that the risk to the Government of accepting bad optical measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION (EIA/TIA)

TIA-455-20	-	Measurement Methods and Test Procedures-Monitoring of Changes in Optical Transmittance (IEC-60793-1-46 Optical Fibers Part 1-46).
TIA-455-15	-	Altitude/Immersion of Fiber Optic Components.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Altitude test. A test performed to determine the integrity of a DUT sealing surfaces/devices and operational capability when simulating rapid descents from a high altitude.

4. Test setup.

4.1 DUT submergence. The DUT shall be submerged in a tank of distilled water within the chamber as specified in TIA-455-15.

4.1.1 Submergence depth. DUT shall be completely submerged. The uppermost point on the DUT shall have a maximum submergence depth of 30 mm (1.2 inch).

4.1.2 Water quality. Distilled water shall not contain material preventing wetting on DUT exposed surfaces, additives, or contaminants.

4.2 DUT cabling connections. DUT cabling connections that interface with the ports on optical measurement instrumentation shall not be submerged and shall be either routed outside the chamber or to an optical interface port (at a plugged port hole in the chamber wall) so that during test optical measurements can be obtained. The change in optical transmittance shall be measured during and after the test.

4.3 Test fixture and other non DUT masses inside the chamber.

4.3.1 Test fixture. If used, test fixture must be of minimum mass and approved by the Government technical authority.

4.3.2 Non DUT masses. No other mass (item that causes significant thermal lag) shall be added inside the chamber.

4.4 Vacuum equipment and measurement.

4.4.1 Equipment. Equipment shall be capable of reducing the pressure to 25.0 +0.0/-5.0 mm of mercury (1.0 +0.0/-0.2 inch of Hg)) within a maximum duration of 5 minutes. The equipment shall be capable of maintaining this reduced pressure of 25.0 mm of Hg (1.0 inch of Hg) or 3.39 kPa for a minimum of 30 minutes within a tolerance of ±5 percent (such as ±0.1 kPa or ±.03 inch of Hg). A pressure of 25 mm (1.0 in) of Hg converts to a pressure of 3.39 kPa and is equivalent to the pressure found at 75,000 feet.

4.4.2 Measurement. Instrumentation shall be capable of measuring the reduced pressure to within a tolerance of ±5 percent (± 0.1 kPa or ±.03 inch of Hg).

5. Test procedure.

5.1 Test method. DUT assemblies (test samples) shall be tested in accordance with TIA-455-15 for altitude using the stated number of cycles with the ramp/soak times.

5.2 Test synopsis.

a. Perform pre-test visual exam for any damage.

b. Place DUT assemblies in the tank of distilled water inside the chamber as specified in 4.1. The DUT assemblies may be mounted in a test fixture, if required to secure the DUT assemblies in place.

c. Perform setup and allow DUT assemblies to relax and test equipment to stabilize for 24 hours at 25°C.

d. Record pre-test optical transmittance of DUT assemblies at 25°C.

e. Unless otherwise specified in the component military specification, perform test as follows: DUT shall be tested in accordance with TIA-455-15. Perform 3 cycle altitude immersion test as specified in 5.2e(1) through 5.2e(10).

(1) Ramp to reduced pressure. Reduce pressure in the chamber to 25.0 +0.0/-5.0 mm of mercury (1.0 +0.0/-0.2 inch of Hg) within a maximum duration of 5 minutes.

(2) Soak time at reduced pressure (simulated high altitude). Maintain this reduced pressure of 25.0 mm of Hg (1.0 inch of Hg) or 3.39 kPa for a minimum of 30 minutes within a tolerance of ±5 percent (±0.1 kPa or ±.03 inch of Hg).

(3) Ramp to room atmospheric pressure. Increase pressure in the chamber to the room ambient pressure within a maximum duration of 1 minute.

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(4) Soak time at room atmospheric pressure (low altitude). Maintain this room ambient pressure for a minimum of 30 minutes.

(5) Repeat cycle. Repeat the cycle specified in 5.2e(1) through 5.2e(4) two additional times for a total of three cycles.

(6) Perform an optical transmittance measurement after completion of the third cycle.

(7) Remove the DUT assemblies from the distilled water tank and pat or wipe DUT assemblies with a suitable towel.

(8) Allow DUT assemblies to relax and test equipment to stabilize for 24 hours after the test at 25°C and room ambient pressure.

(9) Measure and record optical transmittance of DUT assemblies at 25°C.

(10) Perform post test visual exam (see 5.4).

5.3 Optical measurements.

5.3.1 Change in optical transmittance The change in optical transmittance shall be measured during and after the test (from a baseline obtained before each test) in accordance with TIA-455-20 for transmitted power adhering strictly to the setup and test procedure specified in MIL-STD-1678-2 measurement 2102. During each test cycle, optical transmittance measurements shall be made at each ramp and during the plateau. The requirements for change in optical transmittance shall be met during and after the test.

5.3.2 Optical instrumentation capacity. This optical monitoring assumes that an optical measurement system is available with a sufficient channel measurement capability and that only one optical source exists that requires only one monitoring channel (to monitor and compensate for optical source drift).

5.4 Post test visual examination. Inspection of the DUT shall reveal no leakage or other apparent loss of sealing capability, no deposits on ferrule, no surface or identification marking impairment, nor any damage detrimental to the operation of the DUT.

5.5 End face geometry. When DUTs are comprised of connectors or termini, the ferrule end face of each connector/termini mated pair shall be inspected for end face geometry. Inspection for end face geometry shall be performed before the test sequence and after the conclusion of the test sequence. Ferrule end face geometry shall be inspected as specified in MIL-STD-1678-5 measurement 5201.

5.6 Contamination. When DUTs are comprised of connectors or termini, the ferrule end face of each connector/termini mated pair shall be inspected for cleanliness after the completion of the test or during specified points during and after the completion of the test, as specified. Inspection shall be performed using a Fiber Optic Video Inspection System (FOVIS). As an option, each end face shall be captured using software provided with the FOVIS. For each cleaning operation performed, a table is requested to summarize the number of cleaning steps, cleaning device, cycle used, and result.

5.7 Data sheet. In addition to the items for the standard data sheet listed in MIL-1678-2 Measurement 2201, the data sheet is to list the items in 5.7a through 5.7c.

a. Specify chamber room ambient to reduced pressure ramp rate.

b. Specify chamber reduced pressure to room ambient ramp rate.

c. Specify chamber limit for reduced pressure.

6. Notes.

6.1 Intended use, qualification testing. Stresses are applied to show compliance with specification requirements.

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APPENDIX A

MINIMUM ESSENTIAL CHECKLIST FOR ALTITUDE IMMERSION MEASUREMENTS

A.1 Purpose. This appendix addresses a checklist of the minimum essentials for the altitude immersion measurement.

A.2 Usage. Table 3305A-I is the checklist of minimum essentials for Government auditors, or their representatives, to use during inspections. This checklist should be expanded at the auditor's discretion.

TABLE 3005A-I. Minimum essential checklist for altitude immersion measurements.

Item	Category	Item	Requirement	Compliance
1	Test sample configuration	Cable assembly length: connectors and splices	10 meters minimum (13 m if 3 cut-backs)	
			Complies with part 4 of this standard practice	
2	Room ambient environmental condition	Standard ambient (if test equipment built to operate in this range, if not-then controlled ambient)	23°C ±5°C/73°F ±9°F and 20% to 70% RH	
		Controlled ambient	23°C ±2°C/73°F ±4°F and 45% to 55% RH	
3	Test condition	Test setup cable routing	Bend diameters ≥ min long term bend diameter	
			Sharp twists and bends avoided	
			Avoid protrusions/other obstacles	
4	Environmental Chamber charts	Altitude profiles recorded	Chart, stored data on disk, other approved means	
			Includes chamber model and serial, date of test	
	Test equipment			
5	Environmental chamber	Ramp to reduced pressure rate of change	Within a maximum of 5 minutes reducing the pressure to 25.0 +0.0/ -5.0 mm of mercury (1.0 +0.0/-0.2 inch of Hg)	
		Ramp to room ambient pressure rate of change	Within a maximum of 1 minute	
		Soak at reduced pressure	25.0 mm of Hg (1.0 in of Hg) or 3.39 kPa for a minimum of 30 minutes within a tolerance of ± 5 percent (±0.1 kPa or ±.03 inch of Hg)	
		Soak at room ambient pressure	Minimum of 30 minutes	
		If programmable to perform cycles	3 cycles at 66 minutes/cycle	
6	Optical measurements	Change in optical transmittance	Compliance with MIL-STD-1678-2 measurement 2101	

TABLE 3005A-I. Minimum essential checklist for altitude immersion measurements - Continued.

Item	Category	Item	Requirement	Compliance
7	Pressure measurements	Reduced pressure or vacuum	Measure the reduced pressure to within a tolerance of ± 5 percent (±0.1 kPa or ±.03 inch of Hg)	
8	Examinations	Visual inspection	No leakage, loss of sealing capacity, deposits on ferrule, damage detrimental to operation,	
		Ferrule end face contamination	FOVIS inspected and cleaned. Table provided summarizing cleaning steps, cleaning device, cycle used, and result.	
		Ferrule end face geometry	Compliance with MIL-STD-1678-5 measurement 5201	
9	Test setup	Optical fiber connections	Routed outside chamber or to an optical interface port at chamber wall	
		Test fixture, if used	Minimize mass	
			Approved by Government tech authority	
			No other mass inside chamber	
		Items to minimize variation in test	Secure/tie down cables (no move at instr. ports)	
10	Test	Test processes	Compliance with MIL-STD-1678-5 measurement 5101	
		Maintain setup during test (source end)	No disconnection allowed until after testing completed (see MIL-STD-1678-2 measurement 2101)	
		Altitude cycle	Graph or electronic means to verify specified cycles are obtained	
		Alteration in altitude cycle limits, if altered	Same ramp rates occur	
			Same altitude soak times maintained	
11	Calculation	Electronically calculated	Verify proper equation in program	
		Operator performed calculations	Verify correct method used and calculated properly	
12	Data sheet	Approved data sheet	Compliance with MIL-STD-1678-2 measurement 2201	
		Added data sheet requirement	Chamber altitude to atmosphere ramp rate	
			Chamber atmosphere to altitude ramp rate	
			Chamber limit for reduced pressure	
		Pressure (altitude) instrumentation	Equipment information and calibration data	
13	Pass/fail criteria	Proper criteria specified	Conforms with SPEC/contract parameters and values	
		Proper criteria implemented	Test operators knows if fail and to verify result	

MEASUREMENT 3305

APPENDIX A

A.3 Notes.

A.3.1 Intended use.

A.3.1.1 Audit team. This checklist is intended to assist Government auditors or their representatives during inspections of the optical measurement system. This checklist may be augmented at the auditor's discretion; however, it is not to be reduced.

A.3.1.2 Test laboratories. When test laboratories prepare to perform altitude immersion or audits, this checklist should be used to supplement measurement 3305, not replace it.

MEASUREMENT 3306

WEATHERING

1. Purpose. This measurement is intended to provide further direction and consistency for weathering in accordance with ASTM D 2565. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF TEST MATERIALS (ASTM International)

ASTM D 2565	-	Standard Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications.
ASTM G 151	-	Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices That Use Laboratory Light Sources.

(Copies of these documents are available online at http://www.astm.org or from ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Weathering. Measurement that replicates exposure to climatic conditions of daylight, moisture, and heat. This measurement does not simulate DUT deterioration caused by other environmental conditions such as salt air, pollution, or combustion products (such as sulfur dioxide – SO_2) or sudden changes in atmospheric pressure.

4. Setup. Measurement 3306 shall be conducted in accordance with the setup specified in ASTM D 2565 with the restrictions specified in 4.1 through 4.5.

4.1 Test sample parameters.

4.1.1 Configuration. DUT assembly configuration shall be in accordance with the fiber optic component military specification.

4.1.2 Coil of cable. When DUT consists of a coil of cable, then DUT assembly (test samples) shall consist of both the coil of cable and dumbbell shapes of extruded cable jacket material.

4.1.3 Protective coatings. When DUT consists of panels with various protective coatings, final DUT assembly configuration in addition to coupons (panels) must be tested if performed for qualification versus developmental testing.

4.2 Test fixture provisions. Placement of DUT assemblies in chamber consisting of a coil of cable shall be as performed in 4.2.1 and 4.2.2.

4.2.1 No overlap. Fixture shall contain provisions to ensure that the cable lengths (coils) do not overlap in the chamber.

4.2.2 Exposure placement. Fixture shall be designed so that the cable length and material samples are placed to receive exposure equivalent to that of paint coupons for both the arc lamp and water spray.

4.3 Pre-test visual inspection. Perform a pre-test visual inspection. Check for surface corrosion effects; for any cracks, scratches or other degradation in the exterior material (or protective coating as applicable); and for any other type damage. Observations recorded shall include any corrosive effects, any degradation in the protective coating seen on the external parts, and any damage which would be detrimental to the operation of the DUT assembly

4.4 Test instrumentation. Test instrumentation shall be used to measure irradiance in the chamber. Verify test instrumentation complies with 4.4.1 and 4.4.2.

4.4.1 Temperature. Thermometer or temperature measuring system shall be calibrated and be accurate to ±0.5°C (±1°F).

4.4.2 Irradiance. Irradiance measuring system calibration information and accuracy.

4.5 Test chamber parameters.

4.5.1 Temperature control. Chamber shall be capable of controlling the interior test area to within ±2°C (±3°F).

4.5.2 Water purity. The purity of the water shall be sufficient that no spots or stains are caused by positively or negatively charges ions, organics, silica or other impurities in the water.

5. Test procedure. Measurement 3306 shall be conducted in accordance with the processes specified in ASTM D 2565 and conditions per table 3306-I, with the restrictions specified in 5.1 through 5.3.

TABLE 3306-I. Conditions for weathering tests.

Conditions	
Xenon arc lamp Borosilicate glass filters irradiance	6,000 Watts 0.35 Watts per square meter at 340 nm
Procedure	
Exposure – arc lamp on	18 hours Black panel temp 63 ±2°C Relative humidity 50 ±2 percent (Water is sprayed onto the specimen for 18 minutes every 2 hours)
arc lamp off	6 hours Temperature 25 ±2°C Relative humidity 90 to 95 percent
Total exposure	1,200 hours

MEASUREMENT 3306

5.1 Summary. Measurement shall be performed as follows:

a. Perform the test for a 1,200 hour exposure.

b. Perform a post test visual inspection after test is completed.

5.2 Post test visual inspection. Once cleaned and dried, the DUT assemblies shall be examined under three-power magnification. Inspect for both characteristics listed in 5.2.1 and 5.2.2.

5.2.1 Interior penetration. Check for water penetration into the DUT assembly interior; especially pass any openings, gaskets or seals, and threaded connections.

5.2.2 Material damage effects. Check for surface damage or protective coating degradation and for damage to external parts. Observations recorded shall include any damage seen on the external parts which would be detrimental to the operation of the DUT assembly (including mechanical mating).

5.2.3 Cable jacket criteria. Check for softening, gumminess, or surface damage (cracking, splitting, or other defects to permit jacket penetration).

5.2.4 Cable jacket extruded material. Perform a jacket tensile strength and elongation after completion of the weathering test.

5.3 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 method 2201, the data sheet is to list the items in 5a through 5f.

a. Type of light source used to simulate sunlight.

b. Type and age of filters at the beginning of the test.

c. Changes, if any, of filters after the test.

d. Irradiance recorded throughout the test.

e. Conformance verification of water purity to ASTM G 151 or other standard for water purity.

f. Parameters used if not a standard model commercial chamber or not standard for that standard model chamber.

(1) Type of black panel with operating temperature.

(2) Type of spray nozzle.

(3) Method of achieving relative humidity.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3306

6.2 Power level versus irradiance.

6.2.1 Background. MIL-PRF-85045 test method for weathering contains table XVI that specifies the testing parameters. Two of these parameters are (1) the lamp type and power level (2) and the irradiance to be produced. Testing is to be done using a Xenon arc lamp set at a power level of 6,000 Watts. The irradiance to be produced is 0.35W/m^2 ±0.02 W/m^2 at 340 nm.

6.2.2 Xenon arc lamp wattage versus irradiance. The irradiance is the test parameter of interest. For chambers with the capability to monitor and regulate the irradiance at a constant value directly, the wattage of the Xenon arc lamp does not need to be set or regulated. For chambers that lack this regulating capability, the Xenon arc lamp power setting is to be used as the means to regulate the irradiance. For these latter type chambers, records shall be maintained of the Xenon arc lamp usage and power levels increased accordingly to compensate for aging of the Xenon arc lamp components.

6.2.3 Technical note for arc lamp wattage. This note is applicable for one vendor's weathering chambers using a Xenon arc lamp with daylight filters and set to maintain a radiance of 0.35 W/m^2 at the 340 nm wavelength. A Xenon arc lamp with either a 6000 Watt lamp will run around 5,000 watts initially. Likewise, using a Xenon arc lamp with a 12,000 watt (12 kW or 12 kilowatt) Xenon arc lamp will consume roughly the same wattage initially. A difference in power level will be seen as the two Xenon arc lamps age. A 12,000 Watt, Xenon arc lamp will most likely maintain a power level of about 5,000 watts over 8000 hours. The wattage in a 6,000 watt, Xenon arc lamp will increase and most likely reach its maximum power level over this same duration.

MEASUREMENT 3307

FREEZING WATER IMMERSION

1. Purpose. This measurement is intended to provide further direction and consistency for freezing water immersion in accordance with EIA/TIA-455-98. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

EIA/TIA-455-98 - Fiber Optic Cable External Freezing Test.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, **Washington, DC 20036.)**

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Freezing water immersion. Measurement that replicates exposure to climatic conditions of a DUT assembly in a puddle or immersed in water that freezes. The method performed for this measurement does not simulate DUT deterioration caused by the crushing effect of water freezing to ice.

4. Setup. Measurement 3307 shall be conducted in accordance with the setup specified in EIA/TIA-455-98 with the restrictions specified in 4.1 through 4.5.

4.1 Test sample parameters.

4.1.1 Configuration. DUT assembly configuration, including cable length, shall be in accordance with the fiber optic component military specification. When the DUT being tested is the cable and no length is specified for this test, then method A of EIA/TIA-455-98 shall apply.

4.1.2 Water vessel size versus size of DUT assemblies. The size of the water vessel shall be such that, when mated connectors or a coil of cable are placed in the vessel, the mated connectors or coiled cable shall be within 150 mm (5.9 inch) of the sides and bottom of the water vessel, and within 150 mm (5.9 inch) of the surface of the water.

4.2 Placement of DUT assemblies in chamber.

4.2.1 Position of DUT assemblies (see 4.1.2). Keep the DUT assembly evenly spaced, top-to-bottom and on both sides. This spacing avoids a differential pressure from the ice.

4.2.2 Position relative to vessel sides. Place each DUT assembly in a separate vessel so that it is within 150 mm (5.9 in) of sides, water line, and bottom.

a. Keep evenly spaced, top-to-bottom and on both sides, so as not to obtain a differential pressure from the ice.

b. Ensure that DUT assemblies are secured in-place so that there will be no gross movement during freezing.

c. Preference is to use a separate water vessel for each DUT assembly tested. When multiple DUT assemblies are in same water vessel, do not allow them to touch (such as use of a fixture to maintain a fixed separation).

4.2.3 Avoidance of “crushing” effect.

4.2.3.1 Allowance for ice expansion. Select water vessel that has ample area for ice expansion from water.

4.2.3.2 Position from sides. Keep within 150 mm (5.9 in) of the wall to minimize any higher pressure from the ice.

4.2.3.3 Cabling considerations. Axial direction (front and back or direction along length of the optical fiber) can be sufficiently long to allow cables to protrude from top of vessel without contacting sides of the water vessel. (Center DUT in vessel in the axial direction).

4.3 Pre-test visual inspection. Perform a pre-test visual inspection. Check for surface corrosion effects; for any cracks, scratches, or other degradation in the exterior material (or protective coating as applicable); and for any other type damage. Observations recorded shall include any corrosive effects, any degradation in the protective coating seen on the external parts, and any damage which would be detrimental to the operation of the DUT assembly.

4.4 Test instrumentation. Test instrumentation shall be used to measure water/ice temperature in the water vessel. Verify test instrumentation to measure water/ice temperature in the water vessel complies with 4.4.1 and 4.4.2.

4.4.1 Accuracy. Thermometer or temperature measuring system shall be calibrated and be accurate to ±0.5°C (±1°F).

4.4.2 Placement. Place thermometer vertically to measure water/ice temperature at half the height of the vessel water level. Place thermometer horizontally to measure water/ice temperature at the center among the four walls or circumference of the water vessel.

4.5 Test chamber parameters.

4.5.1 Size of interior test area. Chamber shall be of sufficient size to accommodate the size of the water vessel (see 4.2.1).

4.5.2 Cooling rate capacity. Chamber shall have sufficient cooling rate capacity to freeze contents of water vessel at the specified low temperature limit within a reasonable period of time.

4.5.3 Temperature control. Chamber shall be capable of controlling the interior test area to within ±2°C (±3°F).

5. Test procedure. Measurement 3307 shall be conducted in accordance with the processes specified in procedure 1 of EIA/TIA-455-98 with method A, as applicable and with the restrictions specified in 5.1 through 5.3.

5.1 Summary.

a. After setup is completed, allow DUT assemblies to relax and test equipment to stabilize for 24 hours at 25°C.

b. Record pre-test optical transmittance of DUT assemblies at 25°C.

c. Perform test to TIA/EIA-455-98, procedure 1 as follows:

Step	Action	Temperature	Duration
1	Soak at	Ambient (25°C)	24 hours
2	Ramp to	-10°C	
3	Soak at	-10°C	1/
4	Ramp to	-2°C	
5	Soak at	-2°C	2/, 5/
6	Ramp to	Ambient (25°C)	3/
7	Soak at	Ambient (25°C)	4/

1/ Remain at soak temperature until water is completely frozen. Water shall be defined as completely frozen when water temperature reading is -1°C or -2°C.
2/ Remain at soak temperature until 1 hour after optical power is stable.
3/ Ambient temperature is obtained when ice melts and temperature sensor immersed into the water vessel measures a temperature of 25°C.
4/ Remain at soak temperature until 24 hours after optical power is stable.
5/ Record during test optical transmittance measurement 1 hour after temperature has stabilized.

d. After setup is completed, allow DUT assemblies to relax and test equipment to stabilize for 24 hours at 25°C.

e. Record post test optical transmittance of DUT assemblies at 25°C.

f. Perform a post test visual inspection.

5.2 Post test visual inspection. Once cleaned and dried, the DUT assemblies shall be examined under three-power magnification. Inspect for both characteristics listed in 5.2.1 and 5.2.2.

5.2.1 Interior penetration. Check for water penetration into the DUT assembly interior; especially pass any openings, gaskets or seals, and threaded connections.

5.2.2 Material damage effects. Check for surface damage or protective coating degradation and for damage to external parts. Observations recorded shall include any damage seen on the external parts which would be detrimental to the operation of the DUT assembly (including mechanical mating).

MEASUREMENT 3307

5.3 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet is to list the items in 5.3.1 through 5.3.4.

5.3.1 Test duration. Specify the exposure times (ramps and soak periods) at each temperature. Specify any interruption. For any interruption, include its cause and duration.

5.3.2 Visual inspections. Specify in a table the parameters and findings for the pre-test and the post test visual inspections.

5.3.3 Test fixtures. Provide details and sketches/figures of any test fixtures used.

5.3.4 Water tank. Provide dimensions and sketch/figure of water vessel used.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3308

ELECTROMAGNETIC EFFECTS

1. Purpose. This measurement is intended to ensure that the addition of fiber optic components (such as cables or connectors) and related fittings (connectorized or feedthrough) maintain the shielding effectiveness of the pre-existing structure or enclosure at a value that is greater than the minimum specified value. This test is performed to determine the propagation characteristics (either towards attenuation or towards conduction) of the cable through a waveguide or of a connector. In general, look at the test results for a relative increase in the signal strength. This increase relates to a decrease in the shielding effectiveness of the component under test. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.1.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

Electromagnetic Effects Test and Measurement Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 963210/06-007 of 31 October 2005

(Copies of the Electromagnetic Effects Test and Measurement Guide can be obtained at Web Site: https://fiberoptics.nswc.navy.mil/ in the Policy and Guidance section under Testing Information. If unable to access this Web Site, request an application by e-mail to NSWC DD Warfare Systems Department at DLGR_NSWC_Foweb@navy.mil.)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE-STD-299 - Standard Method for Measuring the Effectiveness of Electromagnetic Shielding Enclosures.

(Copies of these documents are available online at http://www.ieee.org or from the Institute of Electrical and Electronic Engineers (IEEE), 445 Hoes Lane, P. O. Box 1331, Piscataway, NJ 08854-1331.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Electromagnetic field. A field characterized by both electric and magnetic field vectors that interact with one another rather than exist independently of each other, as in electrostatic, static magnetic, and electromagnet static fields. The electromagnetic field varies with time at a point and propagates as a wave from its source, whereas the others: although they may be made to vary, do not exist very far from their sources and decay rapidly with distance.

3.2 Electromagnetic radiation (EMR). Radiation is made up of oscillating electric and magnetic fields that propagate with the speed of light. It includes gamma radiation, x-ray, ultraviolet, visible, and infrared radiation, and radar and radio waves. The radiation is propagated with a phase velocity, v, in the propagation medium, given by the relation "v= λf = c/n"; where λ is the wavelength in the propagation medium, f is the frequency generated by the source, c is the velocity of light in a vacuum (approximately 3×10^8 m/s), and n is the refractive index of the propagation medium.

3.3 Electromagnetic spectrum. The frequencies, or wavelengths, are present in given electromagnetic radiation. A particular spectrum could include a single frequency or a wide range of frequencies.

3.4 Electromagnetic wave. The effect obtained when a time-varying electric field and a time-varying magnetic field interact, causing electrical and magnetic energy to be propagated in a direction that is dependent upon the spatial relationship of the two interacting fields that are interchanging their energies as the wave propagates. The two fields define the polarization plane as well as the wave front. The cross-product of the two fields, with the electric field vector rotated into the magnetic field vector, define a vector, called the Poynting vector that indicates the direction of propagation and defines a ray, which is perpendicular to the wave front.

4. Measurement. The DUT shall be measured (tested) for electromagnetic effects as specified in the component military specification with further constrains cited in Electromagnetic Effects Test and Measurement Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 963210/06-007 of 31 October 2005.

5. Implementation. Measurement 3308 shall be conducted in accordance with the methodology specified in Electromagnetic Effects Test and Measurement Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 963210/06-007 of 31 October 2005. The test methodology employed in evaluating the effects of the fiber optic modification to the enclosure shall consist of distinct steps or measurement phases as summarized in 5.1 through 5.5. Specified data shall be provided on the data sheet. Specified parameters shall be documented in the test report.

5.1 Dynamic range (Instrumentation). This step is intended to illustrate that the instrumentation to be employed in the evaluation is working properly and has significant dynamic range (as defined in IEEE-STD-299) to adequately measure the full range of frequency and sensitivity relative to the noise floor to discriminate low levels signals and to establish the baseline signal relationship between the transmit and receiving systems without any attenuation present. This step will also define the repeatable transmit equipment settings to be used in follow on stages of the evaluation.

5.2 Isolation measurement of enclosure shielding (Enclosure). This step will establish the baseline shielding effectiveness of the existing (unmodified) enclosure using the settings and procedures used in the previous step. Measurements made are to include those in the vicinity of utility entrances, doors, and access panels.

5.3 Isolation measurement of enclosure shielding with fitting installed (Enclosure with fitting). This step will determine the resultant shielding effectiveness of the enclosure with the penetrative fitting (feed through or connectorized). Measurements made are to include those in the vicinity of the access panel where the waveguide for testing of cable or receptacle for testing of a connector will later be installed.

5.4 Resultant shielding effectiveness of the DUT (enclosure with DUT installed in fitting). This step will determine the resultant shielding effectiveness of the enclosure with the complete fiber optic cable or connector installation, inclusive of any fittings or hardware.

5.5 Analysis. A comparison of shielding effectiveness levels for pre-existing and modified enclosure configurations, and determination of acceptability of any degradation in shielding effectiveness observed.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3308

MATERIAL MEASUREMENTS

3401 - 3409

MEASUREMENT 3401

FUNGUS RESISTANCE

1. Purpose. This measurement is intended to provide further direction for decontamination, processes, and evaluation criteria for ensuring that this measurement is done in a consistent manner. Former testing has shown inconsistent results. Suspected causes are contamination (test sample, stock cultures and testing apparatus), use of different preparations (such as solutions and mediums) or procedures and different evaluation criteria. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests.

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NAVY SHIPBOARD FIBER OPTICS

Fungus Resistance Test Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 965/001 of 26 January 2007

(A copy of the Fungus Resistance Test Guide can be obtained at web site: https://fiberoptics.nswc.navy.mil/ in the Policy and Guidance section under Testing Information. If unable to access this Web Site, request an application by e-mail to NSWC DD Warfare Systems Department at DLGR_NSWC_Foweb@navy.mil.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Fungi. A term used to identify the two groups of yeasts and molds.

3.2 Conidia. Spores or rounded forms found at the ends of some hyphae.

3.3 Hyphae. The interwoven filaments that are a part of a mold. These filaments form masses (called mycelium).

3.4 Mold/Mould. The five fungi used in the fungus resistance test are molds. Either spelling of “mould” or “mold” can be used. Molds will appear “fuzzy” with moderate to heavy growth. The word “mold” is more commonly used in the United States to describe this group of fungi, “mould” in the United Kingdom. A typical mold can be identified by observing hyphae and conidia.

3.5 Spore suspension. Suspension that is sprayed to inoculate test samples and positive controls consist almost entirely of spores. Most of the filaments remain anchored within the agar matrix in which a mold is grown. Other filaments are filtered out during spore suspension preparation.

4. Measurement. The DUT shall be measured (tested) for its materials being resistant to the effects when exposed to fungi as specified in the component military specification with further direction cited in Fungus Resistance Test Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 965/001 of 26 January 2007. Further direction is provided for decontamination, processes, and evaluation criteria to ensure that this measurement is done in a consistent manner.

5. Implementation. Measurement 3401 shall be conducted in accordance with the methodology specified in Fungus Resistance Test Guide, Qualified Products List, Test Suitability for Fiber Optic Cable Topology Components; NSWCCD-SSES ltr 9504 Ser 965/001 of 26 January 2007. The test methodology employed in evaluating the effects/resistance of the DUT materials to fungus shall include the measurement processes as summarized in 5.1 through 5.4.

5.1 Pre-test decontamination of DUT. Perform as specified using MIL-STD-810 methodology.

5.2 Test process. Conformance shall be documented or otherwise verified for environmental chamber test parameters, maintaining stock cultures (see 4.4.3.1 and 4.4.3.2b of MIL-STD-810, method 508), spore suspension preparation (see 4.4.3.2 of MIL-STD-810, method 508), spore suspension concentration, positive control for stock culture purity (viability control), positive control during testing, and inoculation (4.5 of MIL-STD-810, method 508).

5.3 Post test decontamination of DUT. Perform as specified using MIL-STD-810 methodology.

5.4 Fungus resistance test evaluation criteria. Perform using specified rating criteria with parameters provided to assist in mold identification. Record on data sheet using rating criteria (see sample data sheet cited in section 4 above).

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3402

SALT SPRAY

1. Purpose. This measurement is intended to provide further direction and consistency for simulating a corrosive atmosphere in accordance with TIA-455-16. Specifically, this measurement simulates a DUT assembly being introduced into a salt air environment. No correlation is made between test conditions and exposure time in any natural environment. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF TEST MATERIALS (ASTM International)

ASTM B 117	-	Standard Practice for Operating Salt Spray (Fog) Apparatus.
ASTM E 70	-	Standard Test Method for PH of Aqueous Solutions with the Glass Electrode.

(Copies of these documents are available online at http://www.astm.org or from the ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.)

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA-455-16	-	Fiber Optic Components, Salt Spray (Corrosion), Test for.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Salt spray measurement. Measurement that provides a controlled setting that replicates exposure to climatic conditions in a salt air atmosphere for obtaining a relative measure of the corrosion resistance to this type environment.

4. Setup. Measurement 3402 shall be conducted in accordance with the setup specified in TIA-455-16 with the restrictions specified in 4.1 through 4.5.

4.1 Test sample test preparation. Clean the test samples with reagent grade (> 99 percent pure) isopropyl alcohol prior to the test.

4.2 Placement of DUT assemblies in chamber.

a. Suspend DUT assemblies. Each DUT assembly shall be suspended in the chamber such that no test sample supports or other DUT assemblies are above to drip onto or otherwise cause salt water to collect on another DUT assembly.

b. Position or suspension of each DUT shall be performed so that axial direction is about 15 degrees (range from 6° to 45° is acceptable) from the vertical surface and parallel to the principal direction of the horizontal flow through the chamber.

c. Position of each DUT assembly shall ensure uniform exposure.

d. Suspension wires used shall be wax coated string or other moisture-impervious, non-metallic material.

4.3 Pre-test visual inspection. Perform a pre-test visual inspection. Check for surface corrosion effects; for any cracks, scratches or other degradation in the protective coating; and for any other type damage. Observations recorded shall include any corrosive effects, any degradation in the protective coating seen on the external parts, and any damage which would be detrimental to the operation of the DUT assembly (including mechanical mating) or that may facilitate the onset of corrosion.

4.3.1 Penetration. No salt penetration into sealed areas.

4.3.2 Corrosion. No corrosive effects on external parts that would be detrimental to the operation. These corrosive effects include, but are not limited to, those specified in 4.3.2a through 4.3.2c.

a. Exposure of base metals, pitting, and porosity of finishes.

b. Cracking or delamination of components or finishes.

c. Abnormal nicks, cracks, or scratches on finished surfaces that indicate the removal of any normal protective coating.

4.4 Test instrumentation. Verify test instrumentation complies with 4.4a through 4.4e.

a. Thermometer or temperature measuring system shall be calibrated and be accurate to ±0.5°C (±1°F).

b. Pressure gauge or pressure measuring system shall be calibrated and be accurate to ±6.89 kPa (±1 psi).

c. Graduated cylinders, funnels or other collection container to capture and measure salt fog concentration. Preference is to use a funnel, dish or other collection container that has a diameter of 10 cm (3.94 in) since this horizontal collection area is about 80 cm^2 (12.4 in^2).

d. Specific gravity hygrometer that can measure the specific gravity between 1.0255 and 1.0400 at a fluid temperature of 25°C (77°F).

e. Unless otherwise specified by the qualifying activity, electrometric measurement of pH shall be conducted using a saturated potassium chloride bridge in accordance with ASTM E 70.

4.5 Salt solution preparation. Prepare the salt solution as specified in 8.1 of ASTM B 117 ensuring proper pH (see 8.2 of ASTM B 117).

a. Salt solution shall consist of a 5 percent salt (NaCl) concentration (5 ±1 parts of salt by weight).

b. Salt solution parameters shall be measured at a 35°C (95°F) exposure temperature.

c. Salt solution shall contain a pH between 6.5 and 7.2 when measured in accordance with 4.5.2.

5. Test procedure. Measurement 3402 shall be conducted in accordance with the processes specified in TIA-455-16 with the restrictions specified in 5.1 through 5.4.

5.1 Summary. Operate the salt spray (fog) chamber with a constant salt spray for the specified exposure time (see 6.4).

5.1.1 Test duration. Exposure period shall be as specified in the component military specification (see 6.3).

5.1.2 Salt spray measurement intervals. Measure the salt spray (fog) fallout rate at intervals of every 24 hours.

5.1.2.1 Check pH. Ensure fallout has a pH between 6.5 to 7.2.

5.1.2.2 Check fallout rate. Ensure that for each 80 cm^2 (12.4 in^2) of horizontal collection area in the chamber, there will be between 1 to 2 milliliters of salt solution collected per hour.

5.1.3 Test sample removal. After the exposure period, test samples shall be removed from the chamber.

5.2 Post test cleaning of test samples.

5.2.1 Cleaning. Clean test samples by gently washing or dipping in running tap water (not warmer than 38°C (100°F) for at least 5 minutes.

5.2.2 Drying. Dry immediately with a stream of clean, dry compressed air or inert gas.

5.3 Post test visual inspection. Once cleaned and dried, the DUT assemblies shall be examined under three-power magnification. Inspect for both characteristics listed in 5.3.1 and 5.3.2.

5.3.1 Interior penetration. Check for salt penetration into the DUT assembly interior; especially passed any openings, gaskets, or seals, and threaded connections.

5.3.2 Corrosive effects. Check for surface corrosion effects or protective coating degradation and for damage to external parts. Observations recorded shall include any corrosive effects shall seen on the external parts which would be detrimental to the operation of the DUT assembly (including mechanical mating).

5.4 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 measurement 2201, the data sheet is to list the items in 5.4a through 5.4.f.

a. Salt solution composition. Specify type of salt and water used in preparation of salt solution.

b. Specify in a table, the volume of salt solution collected in milliliters per hour for a horizontal collection area of 80 cm^2 (12.4 in^2).

MEASUREMENT 3402

c. Specific gravity. Specify in a table, the daily concentration or specific gravity at 35°C (95°F) for the salt solution collected.

d. pH. Specify in a table, the pH for the salt solution collected.

e. Test duration. Specify the exposure time with any interruption. For any interruption, include its cause and duration.

f. Visual inspections. Specify in a table the parameters and findings for the pre-test and the post test visual inspections.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.2 Relevance of doing separate salt spray test. There is no direct correlation between measurement 3402, for salt spray (in accordance with ASTM B 117) and measurement 3403, for modified SO_2/salt spray (fog - in accordance with annex 4 of ASTM G 85). Some coatings may do well in a salt environment but not the SO2/salt spray (fog) atmosphere. It may still be appropriate to do both tests. Usually, if the test sample does well in an accelerated test, it will perform well in a similar type environment.

6.3 Test duration. Two different exposure periods or test durations are specified usually for fiber optic components. A test duration of 96 hours is specified for fiber optic components used exclusively inside enclosures. A test duration of 500 hours is specified for fiber optic components exposed to the outside (natural) environment (or atmosphere).

6.4 Equivalency. Parameters specified in TIA-455-16 are equivalent to MIL-STD-202, method 101.

MEASUREMENT 3403

MODIFIED SO_2/SALT SPRAY

1. Purpose. This measurement is intended to provide further direction and consistency for simulating a corrosive atmosphere in accordance with ASTM G 85. Specifically, this measurement simulates a pollutant/combustion product (sulfur dioxide or SO_2) periodically being introduced into a salt air environment. No correlation is made between test conditions and exposure time in any natural environment. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF TEST MATERIALS (ASTM International)

ASTM B 117	-	Salt Spray (Fog) Apparatus, Operating.
ASTM E 70	-	Standard Test Method for PH of Aqueous Solutions with the Glass Electrode.
ASTM G 85	-	Salt Spray (Fog) Testing, Modified.

Copies of these documents are available online at http://www.astm.org or from ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Modified SO_2/Salt spray measurement. Measurement that provides a controlled setting that replicates exposure to climatic conditions for a pollutant in a salt air atmosphere. This measurement obtains a relative measure of the corrosion resistance to this type environment.

4. Setup. Measurement 3403 shall be conducted in accordance with the setup specified in ASTM G 85 with the restrictions specified in 4.1 through 4.6.

4.1 Test sample test preparation. Clean the test samples with reagent grade (> 99 percent pure) isopropyl alcohol prior to the test. Prepare the salt solution as specified in 8.1 of ASTM B 117 ensuring proper pH (see 8.2 of ASTM B 117).

4.2 Placement of DUT assemblies in chamber.

a. Suspend DUT assemblies. Each DUT assembly shall be suspended in the chamber such that no test sample supports or other DUT assemblies are above to drip onto or otherwise cause salt water to collect on another DUT assembly.

b. Position or suspension of each DUT shall be performed so that axial direction is about 15 degrees (range from 6° to 45° is acceptable) from the vertical surface and parallel to the principal direction of the horizontal flow through the chamber.

c. Position of each DUT assembly shall ensure uniform exposure.

d. Suspension wires used shall be wax coated string or other moisture-impervious, non-metallic material.

4.3 Pre-test visual inspection. Perform a pre-test visual inspection. Check for surface corrosion effects; for any cracks, scratches, or other degradation in the protective coating; and for any other type damage. Observations recorded shall include any corrosive effects, any degradation in the protective coating seen on the external parts, and any damage which would be detrimental to the operation of the DUT assembly (including mechanical mating) or that may facilitate the onset of corrosion.

4.3.1 Penetration. No salt penetration into sealed areas.

4.3.2 Corrosion. No corrosive effects on external parts that would be detrimental to the operation. These corrosive effects include, but are not limited to, those specified in 4.3.2a through 4.3.2c.

a. Exposure of base metals, pitting, and porosity of finishes.

b. Cracking or delamination of components or finishes.

c. Abnormal nicks, cracks or scratches on finished surfaces that indicate the removal of any normal protective coating.

4.4 Test instrumentation. Verify test instrumentation complies with 4.4a through 4.4f.

a. Thermometer or temperature measuring system shall be calibrated and be accurate to ±0.5°C (±1°F).

b. Pressure gauge or pressure measuring system shall be calibrated and be accurate to ± 6.89 kPa (±1 psi).

c. Graduated cylinders, funnels, or other collection container to capture and measure salt fog concentration. Preference is to use a funnel, dish, or other collection container that has a diameter of 10 cm (3.94 in) since this horizontal collection area is about 80 cm^2 (12.4 in^2).

d. Specific gravity hygrometer that can measure the specific gravity between 1.0255 and 1.0400 at a fluid temperature of 25°C (77°F).

e. Unless an allowance is granted by the qualifying activity, electrometric measurement of pH shall be conducted using a glass electrode with a saturated potassium chloride bridge in accordance with ASTM E 70.

f. Flow meter and timer to regulate SO_2 gas introduced into the chamber.

4.5 Salt solution preparation. Prepare the salt solution as specified in 8.1 of ASTM B 117 ensuring proper pH (see 8.2 of ASTM B117).

a. Salt solution shall consist of a 5 percent salt (NaCl) concentration (5 ±1 parts of salt by weight).

b. Salt solution parameters shall be measured at a 35°C (95°F) exposure temperature.

c. Salt solution shall contain a pH between 6.5 and 7.2 when first prepared then measured in accordance with 4.5b.

4.6 Purity of gas cylinder. Purity shall be greater than 99 percent of SO_2 gas in cylinder.

5. Test procedure. Measurement 3403 shall be conducted in accordance with the processes specified in ASTM G 85 with the inclusion of Annex A4 and with the restrictions specified in 5.1 through 5.5.

5.1 Summary. Operate the modified SO_2/salt spray (fog) chamber with a constant salt spray introducing SO_2 gas for 1 hour four times a day (every 6 hours in accordance with A.4.4.4.1 of ASTM G 85).

5.1.1 Test duration. Exposure period shall be 336 hours.

5.1.2 Gas flow rate. Introduce the SO_2 gas at a flow rate of 1 cubic centimeter per minute per cubic foot (cm^3/min-ft^3) (35 cubic centimeters per minute per cubic meter (cm^3/min-m^3)) of cabinet volume.

5.1.3 Gas flow dispersion uniformity. A method shall be used that ensures uniform dispersion throughout the chamber interior (such as gas dispersion ring).

5.1.4 Salt spray measurement intervals. Measure the salt spray (fog) fallout rate at intervals of every 24 hours and ensure fallout has specified pH (2.5 to 3.2) and a rate of 1 to 3 ml/80cm^2/hr.

5.1.5 Test sample removal. After the exposure period, test samples shall be removed from the chamber.

5.2 Post test cleaning of test samples.

5.2.1 Cleaning. Clean test samples by gently washing or dipping in running tap water (not warmer than 38°C (100°F)) for at least 5 minutes.

5.2.2 Drying. Dry immediately with a stream of clean, dry compressed air or inert gas.

5.3 Post test visual inspection. Once cleaned and dried, the DUT assemblies shall be examined under three-power magnification. Inspect for both characteristics listed in 5.3.1 and 5.3.2.

5.3.1 Interior penetration. Check for modified SO_2/salt penetration into the DUT assembly interior; especially pass any openings, gaskets, or seals, and threaded connections.

5.3.2 Corrosive effects. Check for surface corrosion effects or protective coating degradation and for damage to external parts. Observations recorded shall include any corrosive effects shall seen on the external parts which would be detrimental to the operation of the DUT assembly (including mechanical mating).

5.4 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 measurement 2201, the data sheet is to list the items in 5.4.1 through 5.4.6.

5.4.1 Salt solution composition. Specify type of salt and water used in preparation of salt solution.

5.4.2 Specifications. Specify in a table, the daily volume of salt solution collected in milliliters per hour for a horizontal collection area of 80 cm^2 (12.4 in^2).

5.4.3 Specific gravity. Specify in a table, the daily concentration or specific gravity at 35°C (95°F) for the salt solution collected.

5.4.4 pH. Specify in a table, the daily pH for the salt solution collected.

5.4.5 Test duration. Specify the exposure time with any interruption. For any interruption, include its cause and duration.

5.4.6 Visual inspections. Specify in a table the parameters and findings for the pre-test and the post test visual inspections.

5.5 Safety. Adequate safety measures must be taken during this test.

5.5.1 Measurement and dispersion periods shall not coincide. Fallout rate measurements and otherwise opening of the chamber shall not occur during an SO_2 cycle (dispersion period).

5.5.2 Sufficient exhaust time prior to opening. Once the chamber is opened, sufficient time must be allotted for exhaust hood or other means of ventilation to remove the SO_2 atmosphere prior to exposure to the chamber interior.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

6.2 Relevance of doing separate salt spray test. There is no direct correlation between measurement 3402, for salt spray (in accordance with ASTM B 117) and measurement 3403, for modified SO_2/salt spray (fog: in accordance with annex 4 of ASTM G 85). Some coatings may do well in a salt environment but not the SO_2/salt spray (fog) atmosphere. It may still be appropriate to do both tests. Usually, if the test sample does well in an accelerated test, it will perform well in a similar type environment.

MEASUREMENT 3404

OZONE EXPOSURE

1. Purpose. This measurement is intended to provide further direction for equipment, setup, processes and evaluation criteria for ensuring that this measurement is done in a consistent manner. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF TEST MATERIALS (ASTM International)

ASTM D 1149 - Standard Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment.

(Copies are available online at http://www.astm.org or from ASTM International, 100 Barr Harbor, P. O. Box C700, West Conshohocken, PA 19428-2959.)

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA-455-189 - Ozone Exposure Test for Fiber Optic Components.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Specimens. Polymeric material parts from the DUT.

4. Setup. Measurement 3404 shall be conducted in accordance with the setup specified TIA-455-189 with the restrictions specified in 4.1 through 4.4.

4.1 Test samples. Perform on polymeric parts only.

4.2 Specimen configuration during test. If polymeric part is expanded on the connector, then part is to be tested to the same level of expansion. Parts to be expanded will be provided on applicable mandrel size.

4.3 Sample size. Specimens tested shall consist of 3 of each polymeric part in the fiber optic component under test.

4.4 Test chamber sufficiency. Verification shall be provided that the ozone chamber is suitable for ozone exposure in accordance with TIA-455-189. Most ozone exposures measurements are performed at lower ozone concentrations for longer durations. Ozone exposure in accordance with TIA-455-189 is performed at higher ozone concentrations for shorter durations.

5. Test procedure. Measurement 3404 shall be conducted in accordance with the methodology specified TIA-455-189 with the restrictions for processes and evaluation criteria specified. Measurement processes shall include those summarized in 5.1 through 5.8. Requirements for pass/fail criteria shall include comparison of pre-test and post test visual inspections to ensure seals shall show no evidence of excessive swelling or embrittlement which may degrade environmental isolation.

5.1 Perform pre-test visual inspection. Inspect each test sample under 3X to 5X minimum magnification for any damage, swelling, or embrittlement.

5.2 Perform pre-test dimensional and weight measurement. Dimensional and weigh inspections shall be performed on each polymeric test sample prior to testing unless otherwise specified.

5.3 Sample suspension. Suspend samples in the chamber so that there is a uniform distribution of the ozone concentration around the outer surface of each test sample.

5.4 Perform ozone test. Polymeric connector parts shall be tested in accordance with TIA-455-189 and exposed to an ozone concentration of 100 to 150 parts per million at a temperature of 70°C ±5°C (158°F ±13°F) for two hours. The air velocity in the exposure chamber during the test shall be not less than 0.6 m/sec. The ozone test apparatus and ozone measuring device shall be in accordance with ASTM D 1149. If a polymeric connector part is expanded on the connector, then the part is to be tested at the same level of expansion.

5.5 Remove test samples after the 2 hour exposure.

5.6 Perform post test visual examine. Visually inspect polymeric test samples under 3X to 5X minimum magnification for swelling, embrittlement or any damage.

5.7 Perform post-test dimensional and weight measurement. Dimensional and weigh inspections shall be performed on each polymeric test sample prior to testing unless otherwise specified. Weigh to include the calculation for weight change from pre-test values in percent.

5.8 Data sheet. Data sheet including the contents as specified in appendix A.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

6.2 Equivalency. TIA-455-189 is equivalent to EIA-364-14.

MEASUREMENT 3404

APPENDIX A

POST TEST EXAMINATION SAMPLE DATA SHEET FOR OZONE EXPOSURE

Sample:_____

Reference Number/Part:_____

1. Document the physical characteristics of the specimen as it appeared before test. Note characteristics to include those in the following categories.

Pre-test characteristics	Yes	No	Area (%)
Broken or severed			
Pealing or flaking			
Discoloration			
Noticeable change in size			
Other (list type below)			

2. Document pre-test size and weight.

Size (assumes specimen with diameter and thickness dimensions)

Diameter:_____

Thickness:_____

Weight:_____

3. Document the physical characteristics of the specimen as it appeared immediately after test is completed. Note characteristics to include those in the following categories.

Post test characteristics	Yes	No	Area (%)
Easily broken or snapped			
Pealing or flaking			
Color transfer			
Noticeably brittle			
Other (list type below)			

4. Document post test size and weight. Include change in sizes and weights.

Size (assumes specimen with diameter and thickness dimensions)

Diameter:_____ Change in diameter:_____

Thickness:_____ Change in thickness: _____

Weight:_____ Change in weight:_____

MEASUREMENT 3405

SMOKE GENERATION AND FLAME PROPAGATION

1. Purpose. This measurement is intended to provide further direction and consistency for smoke generation and flame propagation in accordance with the Steniner Tunnel Test as described in UL-910 (horizontal fire test chamber with a ladder type cable tray). To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a "standardized" approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF TEST MATERIALS (ASTM International)

ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

(Copies of these documents are available online at http://www.astm.org or from ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.)

NATIONAL FIRE PROTECTION ALLIANCE (NFPA)

NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

(Copies are available online at http://www.nfpa.org/catalog/ or from National Fire Protection Association, 11 Tracy Drive, Avon, MA 02322.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Smoke. Products of combustion that become airborne and obscure or reduce light transmission.

4. Setup. Measurement 3405 shall be conducted in accordance with the setup specified in NFPA 262 with the restrictions specified in 4.1 through 4.4.

4.1 Test samples.

4.1.1 Length. 7.3 ±.15 m (24 ±0.5 feet) installed in a single layer of straight, parallel rows to fill the width of the tray without spaces between adjacent rows.

4.1.2 Diameter. A micrometer, vernier calipers or a diameter tape with an accuracy of 0.025 mm (.001 inch) minimum can be used. For rounded and for uniform cross sections, perform a minimum of five measurements over a 0.3 m (1 foot) length. The average of the five measurements is used as the diameter. For non-uniform cross sections with width to thickness ratio less than 2:1, take three measurements at wide points and three at narrow points. The diameter is the average of the six measurements. For non-uniform cross sections with width to thickness ratio greater than 2:1, use the width of the cable as the diameter. Take six measurements at six locations on a 0.3 m (1 foot). The diameter is the average of the six measurements.

4.2 Test apparatus verifications.

4.2.1 Apparatus dimensional suitability. Obtain documented evidence of test chamber compliance to dimensions, materials and construction specified in NFPA 262.

4.2.2 Standard insulated conductor test. Obtain documented evidence that the standard insulted conductor test was performed using the conductor specified and was found to be in compliance with the performance parameters listed in NFPA 262.

4.3 Chamber parameters. Establish chamber parameters (each test, perform the following to establish chamber parameters prior to testing).

4.3.1 Cement board test. Obtain documented evidence that cement board test was performed and was found to be in compliance with the temperature history of the thermocouple as shown in NFPA 262 or figure 7 of ASTM E 84. Most significantly, this test is done to establish the methane (gas) flow rate and is to be done on a monthly basis or prior to performing the test. This test is cited in ASTM E 84 to represent a zero index for the flame spread index. This test is use to plot the flame spread distance versus time relationship or a temperature versus time relationship.

4.3.2 Red oak flooring test. This test was done to set/verify chamber compliance with the time-absorption curve as shown in figure 6 of ASTM E 84 and meets 7.8 and 7.9 of ASTM E 84. This test is used to represent a 100 index. This test is used to plot the flame spread distance versus time relationship and the smoke density versus time relationship.

4.4 Test equipment calibration (setting up chamber parameters).

4.4.1 Calibrate smoke measurement system (monthly).

a Location: On exhaust duct at a point preceded by a 17 ±1 foot length of straight run.

b. Distance from light source to photocell is 160 cm ± 5.08 cm (63 inch ± 2 inch).

MEASUREMENT 3405

c. Photocell calibration. Use following optical density filters: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0. Calculate the optical density (OD) from a measurement with each filter as follows: OD = log (Io/I) where Io = clear beam photoelectric signal, I = photoelectric signal with a neutral density filter.

d. Calibration limits. The calculated values for the OD for each filter shall be within ± 3 percent of the calculated neutral density values. The average deviation of all measurements shall be within ± 1 percent.

4.4.2 Calibrate air flow system and inlet static pressure (monthly).

4.4.2.1 Location. Gauge tap 38.1 cm (15 inch) downstream of air inlet shutter.

4.4.2.2 Verify static pressure stability. Open air dampener 4.82 mm (.19 inch) and establish a static pressure of 37 Pa (.15 inch of water column). Close air inlet. Verify increase to 93 Pa (.375 inch of water column) minimum and no downward trend that would indicate leakage.

4.4.2.3 Verify no particle leakage. Ignite a smoke bomb and induce a positive pressure. Observe for leakage of escaping smoke particles.

4.4.2.4 Inlet air supply. Temperature at 23°C ±3°C (73°F ±5°F) and relative humidity at 50 percent ±5 percent.

4.4.2.5 Air velocity measurement. Air velocity measurement at seven equal points along the width of the chamber and 7 m (23 feet) from the gas burner. The measurements are obtained using a thermal anemometer. The average velocity shall be 1.22 m/s ±0.025 m/s (240 ±5 ft/min). Observe the air inlet static pressure at this velocity. This pressure shall be maintained within ± 5 percent for all testing.

4.4.3 Temperature measurement (Type K thermocouple: Calibrate or replace every six months).

4.4.3.1 Locations: Twenty-three feet from centerline of gas burner and 25.4 mm (1 inch) below top surface, 3.96 m (13 feet) and 7.16 m (23.5 feet) downstream of gas burner and 3.18 mm (.125 inch) below floor surface.

4.4.4 Methane gas.

4.4.4.1 Verify a higher heating value. Methane gas shall be 1,000 ± 20 BTU (thermochemical) per cubic foot. Verification may be done with a gas calorimeter.

4.4.4.2 Gas consumption. A gas meter shall be calibrated and used to record gas consumption. The gas meter shall measure in increments of not more than 2.8 liters (0.1 ft^3).

4.4.5 Data acquisition.

4.4.5.1 Data collected and recorded.

a. Light attenuation from the smoke measurement.

b. Fire test chamber measurements.

4.4.5.2 Measurement intervals. Measure at intervals of 2 seconds or less.

4.4.6 Other.

4.4.6.1 Calibration for determining gas flow rate of chamber. Perform cement board test at intervals of one month or do prior to performing each smoke generation and flame propagation test.

MEASUREMENT 3405

5. Test procedure. Measurement 3405 shall be conducted in accordance with the processes specified in NFPA 262 with the restrictions specified in 5.1 through 5.3.

5.1 Summary.

a. Preheat chamber and allow to cool to 40.6°C (105°F).

b. Install the cable length in the cable tray.

c. Establish an airflow rate of 1.22m/s ± 0.025 m/s (240 ±5 feet/min) by calculating the average of seven measurements.

d. Verify that the smoke measurement system indicates zero optical density.

e. Ignite methane flame and start data acquisition system simultaneously. Record photocell output at a maximum interval of two seconds.

f. Verify that the methane flow meter is at the gas flow rate established during the cement board test setup.

g. Observe and record distance and time of maximum point of flame propagation at intervals of 150 mm (6 inches) as the distance beyond the 137 cm (4.5 feet) ignition burner flame.

h. Stop the test after 20 minutes. (ASTM E 84 stops test after 10 minutes). The smoke and flame spread is to be monitored for the full 20 minutes. The pass/fail criteria for flame spread are at the 10 minute mark. If the lab shuts down the flame source during the test due to over-temperature concerns, smoke and temperature data recording should still continue for the full duration of 20 minutes. The Government will then evaluate the data on a case-by-case basis. This issue does not arise with all cables tested, only those from some vendors.

5.2 Calculations.

5.2.1 Peak optical density. Maximum optical density determined by using a three-point average of optical density values recorded during the test.

5.2.2 Average optical density. Average OD = $[DtS0.5(OD_{i+1} + OD_i)]/1200$ that is summed from I = 1 to I = N-1.

5.2.3 Graphs. Graphs for the flame spread versus time graph must be included in the report.

5.3 Rapid burn rates. Allowances for test duration truncation due to flame spread considerations are addressed in appendix B.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3405

6.2 Single fiber cabling. The smoke generation and flame propagation test is performed on multiple fiber cables that are contained in an outer jacket. For single fiber cables such as the M85045/16, M85045/27, M85045/29 cables, the flaming smoke generation in accordance with ASTM E 662 is performed instead.

6.2.1 Background. This test is not listed in MIL-PRF-85045, but only specified in particular specifications sheets (such as M85045/16). This test applies only to the single fiber cables. Statements that tube ends are to be sealed with a non-flammable sealant are not appropriate for tight buffed, single fiber cables.

6.2.2 Test sample length. This test is to be performed on lengths of cable placed across the face of the sample holder. The size and configuration of the test specimen shall conform to the 76 mm (3 inches) square specified in ASTM E 662. See figure 4 of ASTM E 662. The specimen shall be constructed by laying 76 mm (3 inches) lengths of fiber bundles adjacent to one another to form a 76 mm (3 inches) strip. Wire or cable clamps may be used to permanently hold the fiber bundles in place; however, the exposed length must be 76 mm (3 inches). Longer fiber bundle lengths may be used if the top or bottom clamps are used and cover part of the fiber bundles.

APPENDIX A

MIL-PRF-85045 REQUIREMENTS

A.1 Purpose. This appendix provides in tabular format a listing of the maximum allowed values for insertion loss that are specified in various military fiber optic component specifications.

A.2. Applicable documents.

A.2.1 General. The documents listed in this section are specified in sections A.3 and A.4 of this appendix. This section does not include documents cited in other sections of this appendix or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections A.3 and A.4 of this appendix, whether or not they are listed.

A.2.2 Government documents.

A.2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF TEST MATERIALS (ASTM International)

ASTM E 84 - Surface Burning Characteristics of Building Materials.

(Copies of these documents are available online at http://www. astm.org or from ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.)

A.2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

A.3 Pass/fail criteria. The peak optical density and the average optical density of smoke produced shall be not greater than that specified for the column with the applicable cable type in table 3405A-I. In addition, the flame spread time product at the 10-minute point shall be not greater than 27.5 meters-minutes when calculated in accordance with ASTM-E-84. Tube ends of Blown Optical Fiber (BOF) tube cables shall be plugged with a non-flammable sealant to simulate end caps.

TABLE 3405A-I. Maximum allowed values for peak and average optical densities.

Specification sheet	/13	/15	/17	/18	/19	/20	/25	/26	/28
Peak optical density	0.5	0.5	0.5	0.5	0.5	0.5	1.2	0.5	1.2
Average optical density	0.15	0.15	0.15	0.15	0.15	0.15	0.25	0.15	0.25

A.4 Intended use. Table 3405A-I provides pass/fail criteria to assist Government auditors, or their representatives, during documentation reviews (such as test procedures and test reports) and inspections. Revisions to the military specifications supersede any values found in table 3405A-I.

APPENDIX B

TEST DURATION TRUNCATION DUE TO FLAME SPREAD CONSIDERATIONS

B.1 Intended use. One of the desired cable properties is to be slow burning. The Government recognizes that not all vendors can currently formulate a cable that burns at a rate sufficiently slow as to not encroach into the smoke measurement section of the test chamber during the allotted test duration of 20 minutes. The long term goal is to have all vendors be able to provide cable with sufficiently slow burn rates. Again, it is iterated that this issue does not arise with all cables tested, only those from some vendors.

B.2. Applicable documents.

B.2.1 General. The documents listed in this section are specified in sections B.3 and B.4 of this appendix. This section does not include documents cited in other sections of this appendix or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections B.3 and B.4 of this appendix, whether or not they are listed.

B.2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 262	-	Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

(Copies are available online at http://www.nfpa.org/catalog/ or from National Fire Protection Association, 11 Tracy Drive, Avon, MA 02322.)

B.2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

B.3 Preference. The preference is to perform the test for the specified 20 minutes. For cables with more rapid rates of burning, the following test alternatives are offered in the order of preference listed, to enable the test performed for the full duration.

B.3.1 Substitution of smoke measurement section. If the section of the chamber with smoke measurement hardware is determined to be at risk, an alternate section may be substituted for Navy shipboard cable testing. This alternate section must be constructed of the same dimensions, may include ports for suppressing the fire (adding fire suppressant), and must use the same smoke measurement apparatus as specified in NFPA 262. Also, a correlation in smoke measurement must be submitted between the normally used and substituted test section. This test alternative permits the testing to be done for the full duration of 20 minutes.

B.3.2 Truncate test dependent upon burn rate. The duration in which the test is to be truncated will depend upon the burn rate of the cable. Several runs (using different test samples) may need to be done to establish the point at which the test may be conducted with no danger to test equipment. Each succeeding test would be truncated after a longer duration. This test alternative truncates testing prior to the full duration of 20 minutes. Test truncation occurs due to cable flame continual propagation down the chamber tunnel after the burner flame has been removed. Fire suppressant is added to the chamber tunnel to extinguish the flame prior to the occurrence of chamber damage. Smoke and temperature data recording is truncated at the point fire suppressant is added. The Government will then evaluate the data on a case-by-case basis.

B.4 Premature shutdown of flame source. If the lab shuts down the flame source during the test due to over-temperature concerns, smoke and temperature data recording should still continue for the full duration of 20 minutes. The Government will then evaluate the data on a case-by-case basis.

MEASUREMENT 3406

FLAME EXTINGUISHING

1. Purpose. This measurement is intended to provide further direction and consistency for flame extinguishing in accordance with UL-1685 (a vertical tray flame test). Intent is for the cables to be self-extinguishing and not burn to the top of the tray. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

AMERICAN SOCIETY OF TEST MATERIALS

ASTM D 1835 - Standard Specification for Liquefied Petroleum (LP) Gases.

(Copies of these documents are available online at http://www.astm.org or from ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19428-2959.)

GAS PROCESSORS ASSOCIATION (GPA)

GPA Standard 2140 - Liquefied Petroleum Gas Specifications and Test Methods

(Copies of these documents are available online at http://gpaglobal.org/doclib/ or from the Gas Processors Association, 6526 E. 60th Street, Tulsa, OK 74145.)

UNDERWRITERS LABORATORY (UL)

UL 1685 - UL Standard for Safety Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

(Copies are available online at http://www.ul.com or from Underwriters Laboratories, Incorporated, 333 Pfingsten Road, Northbrook, IL 60062-2096.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Flame. The glowing hot zone of a gas that has just underwent combustion.

4. Setup. Measurement 3406 shall be conducted in accordance with the setup specified in UL 1685 with the restrictions specified in 4.1 through 4.3.

4.1 Test samples.

4.1.1 Sets. Two sets of each cable construction are to be tested (two burns). Each set tested is to be done using previously untested cable.

4.1.2 Length. Each set consists of multiple, 2.44 m (8 feet) cable lengths fastened in a single layer in the cable tray. The number of cable lengths (of a round cable) per set, N = (4/D) + 0.33 where D is the diameter of the cable in millimeters and N is rounded up to the nearest whole number.

4.1.3 Diameter. The following method to measure a diameter is provided as guidance. A micrometer, vernier calipers or a diameter tape with an accuracy of 0.025 mm (.001 inch) minimum can be used. For rounded and for uniform cross sections, perform a minimum of five measurements over a 0.3 m (1 foot) length. The average of the five measurements is used as the diameter. For non-uniform cross sections with width to thickness ratio less than 2:1, take three measurements at wide points and three at narrow points. The diameter is the average of the six measurements. For non-uniform cross sections with width to thickness ratio greater than 2:1, use the width of the cable as the diameter. Take six measurements at six locations on a 0.3 m (1 foot) length. The diameter is the average of the six measurements.

4.2 Test apparatus verifications.

4.2.1 Apparatus dimensional suitability. Obtain documented evidence of test chamber compliance to dimensions, materials, and construction specified in UL 1685.

4.3 Test equipment.

4.3.1 Air velocity measurement.

4.3.1.1 Pressure probe type. Differential pressure measured in flow path using a bi-directional probe (pressure taps on both sides of a diaphragm).

4.3.1.2 Pressure probe location. Place at centerline of duct downstream of last turn in the duct at location to ensure a nearly uniform air velocity across the duct.

4.3.1.3 Pressure measurement device. Pressure transducer having a minimum resolution of 0.025 Pa (.001 inch H_2O).

4.3.1.4 Inlet air supply. Temperature at 23°C ±5°C (73°F ±9°F).

4.3.2 Temperature measurement (exhaust gas).

4.3.2.1 Location: Exhaust gas temperature is to be measured 152 mm (6 inches) upstream from the pressure probe on the centerline of the duct.

4.3.2.2 Temperature sensor type. Type K, 28 AWG (0.08 mm^2) thermocouple with an inconel sheath.

4.3.3 Propane gas.

4.3.3.1 Verify a higher heating value. Propane gas is to be Special Duty propane (as defined in ASTM D 1835) or HD-5 propane (as defined in GPA Standard 2140) and shall have a nominal heating value of 2,500 BTU (thermochemical) per cubic foot. Verification may be done with a gas calorimeter.

MEASUREMENT 3406

4.3.3.2 Gas consumption. A gas meter shall be calibrated and used to record gas consumption. The gas meter shall measure a rate at least 0.00023 m^3/s (29 ft^3 per hour).

4.3.3.3 Air consumption. An air flow meter shall be calibrated and used to record the rate of air flow. The air flow meter shall measure a rate at least 0.00133 m^3/s (170 ft^3 per hour).

4.3.3.4 Measurement accuracy. Gas and air flow measurements are to be accurate within 3 percent.

4.3.4 Data acquisition.

4.3.4.1 Data collected and recorded. Pressure measurements.

4.3.4.2 Measurement intervals. Measure at intervals of 5 seconds or less.

5. Test procedure. Measurement 3406 shall be conducted in accordance with the processes specified in UL-1685 with the restrictions specified in 5.1 through 5.3.

5.1 Summary.

a. Condition the chamber for at least three hours with air at a temperature of 23°C ±5°C (73°F ±9°F) so that the test chamber is dry.

b. Install the cable length in the cable tray.

c. Pre cool chamber to 5°C (41°F) so that cable, chamber and air temperature are in equilibrium.

d. Establish a nominal flow rate of the exhaust air of 0.65 m^3/s ±0.05 m^3/s (23.0 ft^3 ±1.8 ft^3/s) in the duct.

e. Ignite burner and set flow rates. Rate of propane flow shall be 220 cm^3/s ±8 cm^3/s (28 ft^3 ±1 ft^3/hr) when corrected to standard temperature and pressure (20°C, 101 kPa). Rate of air flow shall be 1,280 cm^3/s ±8 cm^3/s (163 ft^3/hr ±1 ft^3/hr) when corrected to standard temperature and pressure.

f. Ignite methane flame and start data acquisition system simultaneously. Record pressure output at a maximum interval of five seconds.

g. Observe and record flame height during the 20 minute test.

h. Stop the test after 20 minutes. Burner flame is to be extinguished and cable fire (if any) is to be allowed to burn itself out.

i Observe and record time in seconds that the cables continue to burn following removal of the burner flame.

5.2 Determination of cable damage.

5.2.1 Measurement resolution. Record cable damage to the nearest 25 mm (1 inch).

5.2.2 Measurement height. Measurement shall be made from the bottom of the tray.

5.2.3 Determination of damage. Burning is considered to be charring, melting, blistering and other damage of the cable from burning of the cable ignited by the burner flame. Soot shall be removed with a cloth after the cables have cooled to room temperature prior to the examination for burning.

5.2.4 Determination of charring. Press on the cable jacket at a number of points. Where a cable surface changes from resilient to brittle (crumbling) is defined as the limit of the char.

5.2.5 Height of damage to top of tray should be clearly specified on the data sheet.

5.3 Data sheet. In addition to the items for the standard data sheet listed in MIL-STD-1678-2 Measurement 2201, the data sheet is to list the items in 5.3a through 5.3c.

a. Flame temperature.

b. Period of time between burner shut off and cessation of flame on the specimen.

c. Overall distance of specimen jacket damage above the burner.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3407

TOXICITY INDEX

1. Purpose. This measurement is intended to provide further direction and consistency for toxicity index in accordance with NES-713. Intent is for the cables to be self-extinguishing and not burn to the top of the tray. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

NES-713 - Naval Engineering Standard, Determination of the Toxicity Index of the Products of Combustion from Small Specimens of Material.

(Copies of Naval Engineering Standards are available from the Naval Sea Systems Command, Code 03J2, Arlington, VA 22206-5160.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Toxicity index. The sum of numerical toxicity factors from selected gases in the combustion products of the material being tested. The toxicity factors are based on the calculated quantity of each gas produced when 100 grams of the material is burnt (in air at a volume of 1 cubic meter). The resulting concentration is one that is fatal at a specified exposure time. An index of 1 (for a given volume) is fatal in 30 minutes (average value). Concentrations fatal at a 30 minute exposure for the selected gases are specified in NES-713 and used in the calculation for the toxicity index.

4. Setup. Measurement 3407 shall be conducted in accordance with the setup specified in NES-713 with the restrictions specified in 4.1 through 4.3.

4.1 Test samples.

4.1.1 Length. 8 cm (3.15 inches).

4.1.2 Exposed cable ends. Preparation shall include sealing cable ends with high temperature cement.

4.2 Test apparatus verifications.

4.2.1 Apparatus dimensional suitability. Obtain documented evidence of test chamber compliance to dimensions, materials, and construction. Specifically, a minimum volume of 0.7 m^3 volume, lined with plastic (polypropylene preferred) and fitted with a transparent plastic panel (polycarbonate preferred).

4.2.2 Required features. Obtain documented evidence that chamber contains the following features: Chamber is air tight and contains airtight ports for sampling positions (to place calorimeter tubers), a forced air extraction system, a mixing fan (six-bladed axial fan with minimum 200 mm diameter, mounted horizontally).

4.2.3 Chamber internal walls and door. Coated with or constructed of an inert non-metallic material.

4.2.4 Burner. Obtain documented evidence that a Bunsen burner for methane with a 125 mm (4.92 inch) overall height, 11 mm (.43 inch) bore burner tube and a 5 mm (.20 inch) bore air and gas inlet tubes are used. Verify that the Bunsen burner is modified to operate from an external air supply (so as not to deplete oxygen in the chamber.)

4.2.5 External flame ignition. Obtain documented evidence that provisions exist for igniting and extinguishing the flame from outside the chamber.

4.2.6 Methane supply. Obtain documented evidence that methane supply has an approximate caloric value of 40 MJ/m^3.

4.3 Test equipment.

4.3.1 Flow measurement. Measurement devices, as required, to establish flame temperature.

4.3.1.1 Air flow. Air flow rate during test is to be set at approximately 15 liters per minute during the test to obtain a flame temperature of 1,150°C ±50°C at the hottest portion of the flame.

4.3.1.2 Methane flow. Gas flow rate during test is to be set at approximately 10 liters per minute during the test to obtain a flame temperature of 1,150°C ±50°C at the hottest portion of the flame.

4.3.2 Temperature measurement (flame temperature).

4.3.2.1 Flame height: Method to measure a 100 mm (approximate) specified flame height from outside the chamber.

4.3.2.2 Temperature sensor. Sensor is able to measure a temperature of 1,150°C ±50°C at the hottest portion of the flame.

4.3.2.3 Measurement method. Method to place the temperature sensor within the hottest part of the flame external to the chamber.

4.3.3 Time measurement. Verify that timing device is capable of measurement periods up to 5 minutes with a minimum accuracy within ±1 second.

4.3.4 Gas concentration measurements.

a. Any analytical system that allows rapid detection and estimation of gases in products of combustion is acceptable.

b. Calorimetric gas reaction tubes are acceptable.

MEASUREMENT 3407

c. Gases to be measured are to include carbon dioxide (CO_2), Carbon monoxide (CO), formaldehyde (HCHO), Nitrogen oxides (NO and NO_2), hydrogen cyanide (HCN), Acrylonitrile (CH_2CHCN), Phosgene ($COCl_2$), Sulfur dioxide (SO_2), hydrogen sulfide (H_2S), Hydrogen chloride (HCl), Ammonia (NH_3), Hydrogen flroride (HF), Hydrogen bromide (HBr), and Phenol (C_6H_5OH).

4.3.5 Mass measurement. Measure test sample to nearest milligram.

5. Test procedure. Measurement 3407 shall be conducted in accordance with the processes specified in NES-713 with the restrictions specified in 5.1 and 5.2.

5.1 Summary.

a. Condition the chamber for at least three hours with air at a temperature of 23°C ±2°C (73°F ±3.5°F) and 50 percent ±5 percent relative humidity for 24 hours.

b. Determine background correction factors for CO, CO_2, and for NO and NO_2 (oxides of nitrogen). Subtract these levels out from measurements taken later with the burning sample.

(1) Position Bunsen burner in center of chamber, ignite and adjust flow rates of air and methane to achieve a flame temperature of 1,150°C ±50°C at the hottest portion of the flame. Record flow rates. Extinguish flame. Vent chamber.

(2) Place CO, CO_2, and oxides of nitrogen reaction tubes in position.

(3) Seal chamber. Ignite Bunsen burner and simultaneous start timing. Maintain flame for one minute, then extinguish flame and start mixing fan. Allow fan circulation for 30 seconds.

(4) Extract portions of chamber atmosphere to determine CO, CO_2, and oxides of nitrogen concentrations.

(5) Open chamber to outside air and evacuate for 3 minutes.

(6) Repeat steps 5.1b(1) through 5.1b(5) except maintain burning condition for two minutes and three minutes in separate runs.

c. Verify air temperature is 23°C ±3°C (73°F ± 5.5°F).

d. Weight test sample.

e. Position Bunsen burner in center of chamber, ignite and adjust flow rates of air and methane to achieve a flame temperature of 1,150°C ± 50°C at the hottest portion of the flame. Record flow rates. Extinguish flame.

f. Place test sample in support and position in center of chamber. Adjust height so that test sample will be positioned within flame boundary and at hottest portion of the flame. Place a thin layer of glass wool on wire mesh to prevent loss due to dripping or melting.

g. Verify forced extraction ventilation system is off.

h. Insert series of colorimeter tubes into chamber.

i. Close chamber door.

j. Turn on air and methane supplies. Simultaneously ignite Bunsen burner and start timing device.

k. Burn period is to continue until complete combustion of test sample occurs. Extinguish flame and record burn time.

l. Start mixing fan, mix for 30 seconds, then switch fan off.

m. Extract portions of chamber atmosphere and draw through each respective detection tube. (If halogens are present, test for halogens first).

n. Open chamber to outside air and evacuate for 3 minutes.

o. Verify complete combustion of the test sample.

p. Repeat steps 5.1.a through 5.1.o with fresh test samples.

5.2 Calculations.

a. Graph results of background correction factors for CO, CO_2, and for NO and NO_2 (oxides of nitrogen) to show rates of build-up with time. Zero time can be shown as 0.03 percent CO_2 and zero for CO, NO, and NO_2. Subtract these levels out from measurements taken later with the burning sample.

b. Calculate Ct, the concentration (ppm) of each gas produced in the test chamber, when 100 g of material is burnt in a 1 m^3 volume using the formula: Ct = (Cx100xV)/m. C = concentration of the gas in the chamber in ppm, m = mass of the test sample in grams, V = chamber volume in m^3.

c. Calculate the Toxicity Index = S [(Ct1/Cf1) +(Ct2/Cf2) +(Ct3/Cf3) + … +(Ctn/Cfn)] where 1,2,3…n represents each gas detected, Cf = concentration of the gas considered fatal to man for a 30 minute exposure time (see Annex A of NES 713 for values).

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

MEASUREMENT 3407

MEASUREMENT 3408

SHELL TO SHELL CONDUCTIVITY

1. Purpose. This measurement is intended to provide further direction and consistency for the measurement of shell-to-shell conductivity. Former testing has shown inconsistent results. Suspected causes are incorrect conversion of units (such as volts to millivolts or amperes to milliamperes), use of different test probes (different applied pressure, different contact area/probe geometry – pointed verses rounded) or equipment (using correct settings on multimeters, placing instrument ends of test probes into correct meter ports) and different evaluation criteria. The content below provides further direction for setup, processes and evaluation criteria. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2. Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-38999	-	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.
MIL-PRF-28876	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Termini, General Specification for

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch/ or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

EIA-364-83	-	Shell to Shell and Shell to Bulkhead Resistance Test Procedure for Electrical Connectors.

(Copies are available from kttp://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Conductivity, electrical. A measure of the ability of a material to conduct an electric current when under the influence of an applied electric field. The conductivity is the constant of proportionality in the constitutive relation between the electrical current density and the applied electric field strength at a point in a material. It is expressed mathematically as $J = \varepsilon E$, where J is the current density, ε is the electrical conductivity, and E is the electric field strength. For example, if J is in amperes per square meter and E is in volts per meter, the electrical conductivity is given as $\sigma = J/E$ amperes/volt-meter, (ohm-meter)', or mhos/meter.

4. Setup. This setup process assumes separate dc power supply, voltmeter, and amp meter are used to perform the test. Other equipment that consists of a combination of this equipment in one package and can consist of a more automated routine for performing the test can be used. If the latter, then the procedure listed must be tailored accordingly.

4.1 Establish open circuit voltage and series circuit current. This procedure assumes separate dc power supply, voltmeter, and amp meter are used to perform the test. Other equipment that consists of a combination of this equipment in one package and can consist of a more automated routine for performing the test can be used. If the latter, then the procedure listed must be tailored accordingly.

a. Turn on the dc power supply.

b. Set voltmeter to V dc and place voltmeter test leads across the power supply (+) and (-) ports.

NOTE: If a multimeter is used, verify that test leads are connected to the correct ports for voltage on the multimeter.

c. Set open circuit voltage on the power supply to 1.5 V dc maximum.

d. Turn off dc power supply.

e. Place the first DUT to be tested in the mounting fixture.

f. Set the amp meter to A dc and place amp meter test leads in the ports on the amp meter.

NOTE: If a multimeter is used, verify that test leads are connected to the correct ports for amps on the multimeter. Also, verify that the multimeter is set for A dc (not for A ac).

g. Place the dc power supply in series with the amp meter and with the DUT by attaching the test leads.

NOTE: This setup should place the dc power supply, amp meter and DUT into a series circuit.

h. Turn on the dc power supply.

i. Set the power supply for 1 ±.1 A dc.

j. Record the value of the current is the series circuit (actual current).

k. Measure the voltage across the dc power supply.

l. Record this dc power supply voltage (verifying it is below 1.5 V dc maximum).

m. Turn off the dc power supply.

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4.2 Identify measurement points on the DUT.

NOTE: This test addresses a shell-to-shell measurement and not a connector plug-to-bulkhead measurement. In the latter measurement, the connector receptacle is mounted to a mounting fixture/simulated bulkhead. The voltage drop is measured from the point specified on the connector plug to a point on the bulkhead next to the connector receptacle mounting flange.

4.2.1 Receptacle-to-plug configuration. Measurement point on a flange mounting connector receptacle shall be next (adjacent) to a flange mounting hole. Measurement point on a jam nut mounting connector receptacle shall be on the flange and next to the o-ring groove on the mounting side of the flange. Measurement point on the connector plug shall be at a point on the rear accessory threads (the threads at the cable entry end of the connector).

4.2.2 Receptacle-to-backshell configuration. Measurement point on a mounting flange connector receptacle shall be next to a flange mounting hole. Measurement point on a jam nut mounting connector receptacle shall be on the flange and next to the o-ring groove on the mounting side of the flange. Measurement point on the backshell shall be at a point on 25.4 mm ± 6.35 mm (1.0 inch ±.25 inch) from the innermost backshell threads that mate with the backshell gland nut.

4.2.3 Plug-to-backshell configuration. Measurement point on the connector plug shall be from a point on the rear accessory thread of the connector plug. Measurement point on the backshell shall be at a point 25.4 mm ± 6.35 mm (1.0 ± .25 inch) from the innermost backshell threads that mate with the backshell gland nut.

4.3 Setup equipment constraints.

4.3.1 Mounting fixture. When a mounting fixture is used, the portion of the mounting fixture used to secure the DUT (Device Under Test) shall be made of a non-conductive material. Otherwise, the DUT shall be measured on a non-conductive surface.

4.3.2 Direct current (dc) power supply. Power supply shall be capable of being set up initially with an open circuit voltage of 1.5 volts dc and capable of maintaining a current during testing of 1.0 amperes ± .1 A dc.

4.3.3 Voltmeter. Voltmeter shall be capable of measurements in the voltage range (to set the initial open circuit voltage) and in the millivolt range (to measure the voltage drop across the shell-to-shell) to within ±2 percent of the applied voltage.

4.3.4 Amp meter. Amp meter shall be capable of measuring the current in the series circuit of 1.0 A dc to within ±0.1 A dc.

4.3.5 Test probe. Test probes used to measure the voltage drop across the shell-to-shell shall have a spherical contact area with a minimum radius of 1.27 mm (.05 inch).

NOTE: The contact area of the test probe and the applied pressure of the test probe to the DUT shell can cause variations in the test measurement. A more pointed test probe can result in a higher voltage measurement. Lighter applied pressures can result in higher voltage measurements. A spring loaded clamping device with a ball or spherical contact surface is the preferred measurement end for a test probe.

4.3.6 Setup schematic. When separate pieces of test equipment are used to perform this measurement, the setup shall be in form of a series circuit for the voltage drop measurement. One test lead from the power supply shall be connected to one end of the DUT assembly. The other test lead from the power supply shall be connected to an Amp meter. The other lead from the Amp meter shall be connected to the other end of the DUT assembly. A volt meter shall be used to measure the voltage drop across the DUT assembly.

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5. Procedure. Fiber optic components shall be tested in accordance with EIA-364-83. In addition, the following requirements for setup, processes, and evaluation criteria apply measurement 3408 shall be conducted in accordance with the methodology specified EIA-364-83 with the restrictions for setup, process and evaluation criteria specified herein and with the data sheet including the contents as specified in appendix A. Measurement processes shall include those summarized in 5.1 and 5.2. Requirements for the MIL-DTL-38999 and MIL-PRF-28876 multiple termini connectors are listed in appendix B.

5.1 Measure voltage drop across the DUT.

a. Place the DUT in the mounting fixture/series circuit path (if not the first DUT to be measured).

b. Turn on the dc power supply.

c. Record the value for the actual current (measured with the amp meter in the series circuit).

NOTE: Ensure that 1 A dc is obtained before proceeding further.

d. Measure the voltage drop across the DUT (see 4.2).

e. Record the voltage drop in millivolts on the data sheet as the measured voltage.

f. Verify the measured voltage does not exceed the maximum required value. If it does, perform steps 5.1f(1) through 5.1f(5).

(1) Measure the voltage drop across component (receptacle, plug, or backshell) and verify that zero voltage (short circuit voltage) is obtained.

(2) If not, then verify that contact point is not on an area of corrosion.

(3) If not, then verify that connector is properly mated (de-mate, then re-mate components).

(4) If not, then check for other phenomena that might cause a lower conductive (higher resistance) current path.

(5) If not, then record that measured voltage drop as a “fail”.

g. Turn off the dc power supply.

h. Remove the DUT from the series circuit.

i. Repeat steps 5.1a through 5.1h for each DUT to be tested.

5.2 Calculate shell-to-shell conductivity (resistance).

5.2.1 Measurement of milllivolts versus resistance. This test is called a shell-to-shell resistance test; however, EIA-364-83 specifies to measure the voltage drop. Other specifications may stipulate the requirement in resistance. If the requirements are specified in terms of millivolts, then the resistance does not need to be calculated.

5.2.2 Measurement of resistance. See 6.2 for an historical account for measuring resistivity versus voltage.

a. The following formula shall be used to determine the calculated resistance:

$$R_c = \frac{V_m}{I_A}$$

Where: R_C = Calculated resistance in MΩ (miliohms).

V_m = Measured voltage in V dc (volts dc).

I_A = Actual current in A dc (Amps dc).

b. Record the calculated resistance in milliohms on the data sheet.

c. Record the value specified for the requirement of calculated resistance.

d. Mark if the DUT is a pass or fail on the data sheet.

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions, and use of specific test practices in addition to specifics for test sample configurations.

6.2 Resistivity measurements. Historically, 4.2 of MIL-STD-1344, method 3007, specified a resistance measurement (thus the name “shell-to-shell conductivity). This test specifies a current of 1.0 ± .1 A dc be used. The measured voltage divided by the actual current is the calculated resistance. Since the actual current = 1 A, the value for the measured voltage is equivalent to the value specified for the requirement of calculated resistance. The unit of measure is millivolts instead of milliamps.

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APPENDIX A

Sample Data Sheet

Project number: Date:
Specification: Tested by:
Specification sheet(s):

Instrumentation used to perform shell-to-shell conductivity test.

Instrumentation	Manufacturer	Model number	Serial number	Calibration due date
DC power supply				NCR A 1/
Multimeter 2/				
Multimeter 3/				

1/ NCR = No calibration required, A = not used to make quantitative measurements (instead multimeters are used).
2/ Multimeter used to set open circuit voltage and in-series current initially, then used for obtain measured voltage for each mated pair. The “in-series” current is current set with DUT (Device Under Test), dc power supply and amp meter in series.
3/ Multimeter used to monitor the in-series current during the test.

Open circuit voltage:
Actual current, initial:

Test sample number	Actual current (A dc)	Measured voltage (V dc)	Calculated resistance (mOhm)	Required max (mV or mOhm)	Pass/ fail

Comments

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APPENDIX B

MULTIPLE TERMINI CONNECTOR REQUIREMENTS

B.1 Purpose. This appendix provides in tabular format a listing of the maximum allowed values for shell-to-shell conductivity that are specified in various military fiber optic component specifications.

B.2 Applicable documents.

B.2.1 General. The documents listed in this section are specified in sections B.3 and B.4 of this appendix. This section does not include documents cited in other sections of this appendix or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections B.3 and B.4 of this appendix, whether or not they are listed.

B.2.2 Government documents.

B.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-38999	-	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environment Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification for.
MIL-PRF-64266	-	Connectors, Fiber Optic, Circular, Plug and Receptacle Style, Multiple Removable Genderless Termini, Environment Resisting General Specification for.

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

B.2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

B.3 Pass/fail criteria. Criteria shall be as specified in B.3.1 through B.3.3.

B.3.1 MIL-DTL-38999 Series III (3.28). Test probe shall not puncture or otherwise damage the plating finish. Maximum measured voltage drop across a connector mated pair (receptacle-to-plug) or assembled connector (connector receptacle or plug-to-backshell) shall be 2.5 millivolts for MIL-DTL-38999 Series III connector at the start of testing. After conditioning (performing a neutral salt spray test or a modified SO_2/salt spray test and the coupling torque), the maximum voltage drop shall be 5 millivolts.

B.3.2 MIL-PRF-64266 (3.14.18) with conductive plating (aluminum and composite shell base). Maximum measured voltage drop across a connector mated pair (receptacle-to-plug) or assembled connector (connector receptacle or plug-to-backshell) at the start of testing (initial) shall be 3 millivolts for MIL-PRF-64266 connector with a conductive plating (both metallic and non-metallic shell materials). After conditioning, the maximum measured voltage drop shall be 5 millivolts.

B.3.3 MIL-PRF-64266 (3.14.18) with conductive plating or no plating (CRES shell base). Maximum measured voltage drop across a connector mated pair (receptacle-to-plug) or assembled connector (connector receptacle or plug-to-backshell) at the start of testing (initial) shall be 10 millivolts for MIL-PRF-64266 connector with a conductive plating (both metallic and non-metallic shell materials). After conditioning, the maximum measured voltage drop shall be 20 millivolts.

B.4 Intended use. B.3.1 through B.3.3 provides pass/fail criteria to assist Government auditors, or their representatives, during documentation reviews (such as test procedures and test reports) and inspections. Revisions to the military specifications supersede any values found in B.3.1 through B.3.3.

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FLUID IMMERSION

1. Purpose. This measurement is intended to provide further direction and consistency for the fluids and processes to be used in this measurement. To ensure that the risk to the Government of accepting bad measurement data is low, to minimize test variations and to permit more accurate comparison of test results from multiple sources, a “standardized” approach is specified to perform this measurement.

2 Applicable documents.

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard practice. This section does not include documents cited in other sections of this standard practice or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, and 5 of this standard practice, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

TT-I-735 - Isopropyl Alcohol

FEDERAL STANDARDS

FED-STD-228 - Cable and Wire, Insulated; Methods of Testing.

(Copies of these documents are available online at https://assist.daps.dla.mil/quicksearch or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ELECTRONICS INDUSTRY ALLIANCE/TELECOMMUNICATIONS INDUSTRY ASSOCIATION

TIA-455-12 - Fluid Immersion Test for Fiber Optic Components.

(Copies are available from http://www.global.ihs.com or to Global Engineering Documents, 1990 M Street NW, Suite 400, Washington, DC 20036.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. Definitions.

3.1 Medium measurement value. The middle value in the data with an odd number of measurements or readings.

4. Measurement. The DUT shall be measured (tested) for its materials being resistant to the effects when exposed to fluids over its service life as specified in the component military specification with further direction cited in measurement 3409. Depending upon component, the tests listed in 4a through 4c may be required as part of this measurement.

a. Tensile strength and elongation retention properties (using specimens of flat extruded polymeric material, such as the cable outer jacket).

b. Outer diameter.

c. Immersion fluids. Immersions shall be performed using fluids with test conditions as specified in appendix A.

5. Implementation. Measurement 3409 shall be conducted in accordance with the methodology specified TIA-455-12 except specimens (each DUT specimen and each sample of polymeric material) shall be exposed to all of the fluids (see 5.5) at the temperatures specified in appendix A. Specimens shall be maintained at ambient conditions for a minimum of 4 hours prior to fluid testing. After immersion, all specimens shall be drained (for at least 10 minutes), blotted to remove excess fluid (without scrubbing or mechanically interacting), rinsed with moderate agitation (using only a back and forth or up and down type motion) for a maximum of 30 seconds in isopropyl alcohol (TT-I-735), blotted dry (without scrubbing or mechanically interacting), and air dried for a minimum of one hour prior to inspection and transfer to subsequent fluid. After testing, each specimen shall be visually examined for conformance to the inspection requirements. The test methodology employed in evaluating the effects/resistance of the DUT materials to fluid immersion shall include the measurement processes as summarized in 5.1 through 5.6.

5.1 Exposure of ends to fluid. Unless ends (or instrument connections) of specimen are sealed environmentally, ends are to be exposed to the atmosphere (not to be immersed into the fluid).

5.2 Certification of proper test fluids. Documentation for verification of each test fluid shall be presented for this test.

5.3 Safety measure with oven type. As a safety measure or unless other precautions are taken, the heated fluids should be done in an explosion proof oven, not an environmental chamber. Vapor build-up in an environmental chamber can cause a hazardous condition.

5.4 Flat extruded sample preparation. Verification of proper dumbbell preparation for flat, extruded samples is to be provided. These are the samples that are to undergo material tensile strength and elongation testing after the completion of the immersions into the specified fluids.

5.5 Number of samples to immerse per fluid.

5.5.1 Fiber optic cable. Separate cable samples are to be immersed in each of the fluids listed. Separate cable jacket samples are to be immersed in each of the fluids listed. In summary, three cable jacket samples are required for each fluid in order to perform the jacket tensile strength elongation (T & E) tests.

5.5.2 Other fiber optic components. DUT assemblies (each DUT specimen and each sample of polymeric material) shall be exposed to all of the fluids at the temperatures specified in appendix A.

5.6 Calculations.

5.6.1 Sample size based on calculation method. When specified for a particular fiber optic component, a minimum of 3 flat, extruded material specimens (such as outer cable jacket) are to be immersed in each fluid prior to performance of a material tensile strength and elongation test (see 5.2 of Federal Test Standard 228, method 3021). Five flat, extruded outer cable jacket material specimens versus three are to be immersed in each fluid; however, if the medium of the results are used for the pass/fail criteria (see 5.3 of Federal Test Standard 228, method 3021).

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5.6.2 Diameter calculation. When specified to measure the outer jacket diameter of the cable or other fiber optic components, the outer diameter measured for swell may be determined by finding diameter in same location 90 degrees apart. Outer diameter may be found by measuring the circumference and calculating the diameter (C=PIxD). Method used to measure outer diameter should be consistent with that specified in an applicable test standard (such as FED-STD-228).

6. Notes.

6.1 Intents behind standardization efforts.

6.1.1 Multiple party testing considerations. The incentive to minimize test variables, resulting in a level playing field for multiple parties testing, leads the Government to establish a baseline. This baseline includes considerations for fabrication of test samples, methods to employ launch conditions and use of specific test practices in addition to specifics for test sample configurations.

TABLE 3409-AI. Fluid immersion test table.

Category	Fluid type	Specification 1/	Test temperature range 1 2/, °C (°F)	Test temperature range 2 3/, °C (°F)
Fuel	Turbine engine fuel reference fluid	AMS 2629, type 1 4/	60 (140)	60 (140)
	Fuel	MIL-DTL-16884	35 (95)	35 (95)
	Automobile gasoline	ASTM D 4814	Not applicable	25 (77)
Hydraulic fluid	Petroleum based, red	MIL-PRF-5606	70 (158)	70 (158)
	Synthetic hydrocarbon/diester based	MIL-PRF-83282	Not applicable	70 (158)
	Synthetic hydrocarbon /PAO based, red	MIL-PRF-87257	Not applicable	70 (158)
		MIL-PRF-17672	60 (140)	60 (140)
	Phosphate ester based	SAE AS 1241, type IV, class 1	Not applicable	70 (158)
Lubricating oil		MIL-PRF-17331	70 (158)	121 (250)
		MIL-PRF-23699	70 (158)	121 (250)
Coolant fluid	Coolanol 25R	5/	60 (140)	60 (140)
	PAO based dielectric fluid	MIL-PRF-87252	Not applicable 6/	60 (140)
Deicer	Aircraft	AMS 1424	Not applicable	60 (140)
	Runway	AMS 1435	Not applicable	60 (140)
Water	Sea	ASTM D 1141	25 (77)	60 (140)
	Reagent 7/	ASTM D 1193	Not applicable	60 (140)
Cleaners/solvents	Isopropyl alcohol	TT-I-735 8/	25 (77)	60 (140)
	Methyl isobutyl ketone	ASTM D 1153 /	Not applicable	60 (140)
	Alkaline detergent	MIL-PRF-85570 10/	Not applicable	60 (140)
Corrosion preventive compound		MIL-PRF-16173, grade 4	Not applicable	60 (140)
		MIL-PRF-81309, type III	Not applicable	60 (140)

1/ Test duration for all fluids is 48 hours in temperature range 2 and 24 hours in temperature range 1.
2/ Unless otherwise specified temperature range 1 is for tri-service components with an operating temperature range of -40°C to 85°C and for Navy shipboard components with an operating temperature range of -28°C to 65°C.
3/ Unless otherwise specified, temperature range 2 is for tri-service aircraft components with an operating temperature range of -55°C to 165°C.
4/ JP-8 conforming to MIL-DTL-83133 may be used in lieu of AMS2629 only if the aromatic content is increased to 25 percent using toluene.
5/ Source of supply: Exxon-Mobile Chemical.
6/ Not applicable is stating that the fluid is not used in the test (not for temperature range 1).
7/ Reagent water is specified in lieu of tap water.
8/ Reagent grade only.
9/ This fluid is being cited in lieu of Methyl Propyl Ketone in accordance with BMS 11-9.
10/ Type II tested with a 4:1 dilution.

Custodians:
Army - CR
Navy - SH
Air Force - 85
DLA - CC

Preparing activity:
DLA - CC

(Project 60GP-2008-042)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.daps.dla.mil/.